THE
PRACTICAL MAGAZINE

NEW SERIES.—No. 8. VOL. 5, 1875.

THE LATE JOSEPH S. WYON, ESQ.

COINS, MEDALS, AND ENGRAVED GEMS.

MEDALS may be defined as pieces of gold, silver, or other metal struck with an emblematic device to commemorate some important event. They are usually more artistically designed and wrought than coins, and do not, like coins, circulate as money.

Commemorative medals were struck in very early times, and coins were still more ancient; but the distinction now made between coins and medals is comparatively of modern origin, since it dates only from the middle ages.

The first pieces of money were probably scraps of metal with no device upon them, and passed from hand to hand by weight. Thus Abraham weighed the 400 shekels of silver because the pieces were unequal. We have reason to believe that about 700 or 800 years before Christ the Lydians issued a coinage, and this is probably the first of which we have any positive knowledge. These coins were uncouth and inartistic, and had a device only upon the obverse side. The reverse was indented with depressions, and the manner of striking these early coins is readily inferred. A lump of metal of the exact weight required for the coin was placed between the die and the pointed tool which took the place of a die on the reverse side, and then powerful blows were given with a hammer till the impression was made.

At a later period two dies were used, one being less elaborate than the other and evidently used to hold the piece of metal in place while the more important image or design was struck upon it by the hammer. These incused reverses were succeeded by those having more regular indentations, sometimes with a small head or other design in the centre of the reverse. The coins were struck cold and the dies were of hard metal, but not so hard as those in use in more modern times.

Pheidon, called in history despot of Argos, coined silver and copper money in the island of Ægina about 770 B.C., and his example was soon followed by the rest of Greece. The first Grecian coins were of silver, while the first Lydian coins were of gold.

The date of Lycurgus is somewhat uncertain, but he is said to have flourished about 844 B.C. and established in Sparta his peculiar currency of iron, and as some say of leather money, in place of gold and silver which was in fashion outside of Lacedæmon. No Spartan took much money with him, for it required a yoke of oxen to move ten minæ (about £36 sterling), and if a man desired to get rich he found it rather discouraging. This rigid law was ridiculed by the rest o. Greece. The iron money had no circulation except in Lacedæmonia. The law was intended to prevent avarice and put down luxury, but with these it put down everything but the warlike spirit. It

kept out of the country everything both good and bad. No commerce existed with other nations; no ships brought merchandize to their harbours, for none was wanted. The law was better than a protective or prohibitory tariff, and Sparta gained only some bubble reputation and little wealth by her opposition to free trade.

Coin engraving has been called the offspring of the art of sculpture, and some of the Greek coins of the best period are models of design. In fact the Greeks surpassed all nations of antiquity in all the arts of sculpture, and no nation has since arisen to rival them, The modern finish and neatness of execution does not appear in their coins and medals, but some of their designs are exquisite. It would be an endless task to speak of all the ancient coins and medals, but a brief reference to a few may be interesting.

The celebrated medal struck at Syracuse, in the reign of Philip of Macedon, bearing on its obverse the head of Proserpina in bold relief is one of the finest specimens of ancient art; on a dolphin under the head appears, but not conspicuously, the name of the artist (ΚΙΜΩΝ) Cimon. On the reverse is a victor at the Olympic games, receiving a wreath from the goddess of Victory. It is singular that the celebrated English coin engraver, who designed the beautiful petition crown to Charles II., for which enormous prices have been realized, should have also borne the name of Simon.

Some of the ancient medals present front faces. The Sicilian artist Cimon executed some in this manner, but the custom was not long followed, obviously because the features of the face were soon disfigured by wear. Many of the gold staters of the Greeks were finely done, as were the coins of Alexander the Great, and those of his successors. The Seleucidæ kings have all given us their faces on their coins. One medal of Antiochus III. (the Great) of Syria is a beautiful specimen, with his head in profile upon it in high relief. During the lifetime of Alexander the Great few coins bore his image, but very many were issued with his profile upon them after his death.

Various emblems appeared upon the Grecian money; Athens chose the owl, sacred to Minerva, the goddess of the city. Macedon had a shield upon its coinage to betoken the prowess of its soldiery.

Rhodes, where the great Colossus stood which was dedicated to Apollo, stamped the head of the fiery god upon its money. Naturally, Delphos selected the dolphin as a device. The legend which appears on many of these coins has been explained in different ways. For example, a coin stamped with the head of Minerva, and having for the legend—"of the Athenians" may be read "money of the Athenians," or more rationally "Minerva of the Athenians." As Diana of the Ephesians was great in Ephesus, so Minerva held the same place of honour in Athens, and in like manner many of the other cities had their tutelary deities, and may have considered this dedication of money a compliment agreeable to their favourite gods and goddesses.

Not very much is known respecting the artists who produced these coins of antiquity. Pliny gives the names of some engravers of gems but not of coins.

The name of Theodotus has been found inconspicuously marked in very small letters on a fine Syracusan coin adorned with the head of Apollo, and there was a celebrated engraver of the island of Crete named Neuanthos.

Names are to be found minutely marked on many coins, but they are not always to be regarded as the names of artists.

We owe to the belief of the ancient Greeks and Romans in that obdurate old ferryman of the Styx, the preservation of many of their finest coins. Money sufficient to satisfy the demands of Charon was always placed in the funeral urns, and generally the best impressions of coins were selected. A great number of coins have been found in the resting places of the dead. At Syracuse a beautiful gold coin was once found between the teeth of a skeleton. The Greeks and Romans stripped the rings from the fingers of the dead, but always left them a little money.

Not many Greek gold coins are now in existence: Pinkerton estimates the whole number of ancient coins remaining to be 80,000, and this is the most liberal estimate. The rage for collecting coins during all the ages has stimulated counterfeiting them. Sometimes two genuine coins have been split, and then been joined so as to make at least one unique specimen. Sometimes coins have been carefully manufactured and buried, and after a time unearthed as if by accident, which speculations remind us of the deception of a more recent date. It is rather singular that nearly all the dies of the genuine ancient coins have perished. A few are in the British Museum, but they are not the oldest. Mr. Burgon says that he saw one during his residence in the East, and failing to persuade its owner to part with it, describes it from recollection as a piece of copper or bell metal, in shape a truncated cone about 3¼ in. high and 3 in. in diameter at the bottom, and 2 in. at the top. In the upper surface was the die for the reverse of a tetradrachm of a Seleucide king of Syria with the device of Apollo seated on a cortina.

It is supposed that the first Roman coins were issued in the reign of Servius Tullius. They were stamped with the head of the two-faced Janus, the doors of whose temple were only open in time of war. The common device on the reverse of the Roman money was the prow of a ship, or rather a galley with oars. First of brass, then of silver, and afterwards of gold, the Roman money did not compare in beauty with the Greek. During the republic serrated coins were issued, bearing a figure representing Victory riding in a chariot, and driving sometimes two horses, sometimes four abreast. The saw-like edge was intended to mark the coin as genuine and to prevent clipping, and was a step towards the modern practice of milling the edges. There were medals in later Roman times with highly finished rims. These may have been prizes for successful athletes, or perhaps they served as admission tickets to view certain games. The Emperor Vespasian, after finishing the Coliseum by the forced labour for ten years of 100,000 Jewish captives, commemorated the event by the issue of bronze sestertii stamped with a device of the building.

The Greek city Byzantium, on the Bosporus, should not be overlooked, for her medals are among the most interesting. The crescent appears on some of her coins. At the time when Philip of Macedon, having overrun Thrace, laid siege to Byzantium, it is related that the people were warned of the approach of their enemies for a night attack by the appearance of a bright light in the north (probably the Aurora) and thus were enabled to defend themselves. They gave Diana credit for this timely warning, and took her crescent for their emblem, and the Turks coming later found nothing better, and adopted it also.

Of modern medals the earliest appeared in the 15th century. Vittore Pisano, who seemed to delight in calling himself a painter, has the honour of restoring the art in Italy. His medals were all cast and very massive. The Florentine medals are celebrated for their portraits of distinguished persons. The papal medals are interesting and numerous. They commemorate leading events, and in reality begin with Paul II., who came to the throne in 1464. His successors completed the series by adding those of the earlier popes. The popes are represented sitting in the papal chair, and are no doubt accurately portrayed. The well-known medal struck by Pope Gregory XIII. to commemorate the Massacre of St. Bartholomew is a ghastly relic of the bigotry of those times.

The doges of Venice have left us a series of interesting medals.

There exists an early medal of John Huss burned at the stake; but its authenticity has been questioned. There are very many German medals. The Dutch medals, struck to keep in memory the events of the sanguinary Spanish wars and butcheries in the Netherlands, are excellent, and are remarkable for their elaborate views.

The French medals were few and unworthy of much notice until the time of the *Grand monarque*. Louis XIV. had a good idea of his own importance in history, and consequently his medals are many. Napoleon Bonaparte's career has furnished subjects for a great number of medallic designs. There are more than 160 of them.

When the Romans conquered Britain they introduced their own coinage. Constantine is said to have had a mint in London. There is an ancient gold medal of David II. of Scotland that was probably struck when he was a captive in England about 1350. Another medal bearing the arms of Kendal is dated 1480; it is large and in the Italian style. A gold medal of Henry VIII. bears his portrait. The series of coronation medals began with Edward VI. The coins and medals of Great Britain have an historical importance, but as a rule they have never been conspicuously beautiful, compared with the Greek. Three famous English artists are exceptions: Simon in the times of Cromwell and Charles II., Croker in the reign of Queen Anne, and Benjamin Wyon.

Without saying anything of the angels and the guineas and all the varieties of the English coinage that have generally been noted for ugliness, since the days of the Druids to the present century, it is noticeable that it was in Elizabeth's reign that the mill and screw took the place of the hammer and punch in coining money.

Medals commemorative of British victories by land and sea (like the Waterloo, Trafalgar, and Crimean medals) have been struck for many years, and most of them are creditable specimens of modern work of this kind; medals for industrial exhibition prizes and for rewards of merit form in our day a very numerous class in every civilized country.

The modern method of die-sinking is first to prepare a draw-

ing in pencil of the work to be executed. It is then transferred in relief into wax. On a block of steel of the required size, and of the finest quality, this design is cut under a magnifying-glass by engraving tools of different sizes and shapes; some are round-pointed, some are sharp-pointed, some are very narrow chisels. As the work progresses, casts are made in wax to test it. The engraving finished, the die is placed in the fire and made white hot, and then plunged into cold water to harden it. It is afterwards tempered, and the smooth surface polished with wax and putty-powder. The engraved part of course is untouched. Coins are struck by one blow of the press; medals, however, if in sharp relief, require a number of blows, and sometimes are struck thirty or forty times before they are completed.

The ancients had a great passion for engraved gems. The Assyrian and Babylonian stone cylinders were from one to two inches in length, and about half an inch in diameter. They were covered with various devices and figures, and used for seals. It is strange that they did not suggest the art of printing, for they embodied the first idea of the cylinder printing press. They were not fine works of art, neither were the stone scarabæi of the Egyptians, that were engraved frequently with signet devices. The Greeks excelled in the beautiful art of engraving gems. They did not attempt cutting the diamond, but it is probable that they used diamond points for tools. In the time of Alexander the Great they attained the highest perfection in the art. As Apelles alone was allowed to paint the great conqueror, so Pyrgoteles alone was permitted to engrave his head. During the Augustan age the Romans with their enormous wealth encouraged this art, and exorbitant prices were paid for the finest works. Dioscorides, a Greek by birth, was their most celebrated artist, and was liberally patronized by Augustus, Mæcenas, and other wealthy Romans. His head of Augustus was adopted by succeeding emperors as their seal. The subjects chosen were many of them mythological, as Apollo flaying Marsyas, Jupiter and Europa, Bacchus and Silenus, Leda and the Swan, &c. Juvenal satirizes the Roman matrons, who had the same passion for these engraved stones that the ladies of the present day have for diamond necklaces and ear-rings. At the time of greatest luxury, both men and women vied with each other in display, and covered their fingers and even their garments with engraved gems.

The cornelian was a favourite stone for engraving, especially the more transparent variety called the sard from Sardes in Lydia.

The onyx also was much used, and the chalcedony for seals and rings.

Varieties of different coloured jasper, and the sardonyx in black, white, blue, and red were favourite stones for signets. The more precious sapphire and ruby were not often engraved, although the secret of cutting these hard stones by their own dust may have been known.

Virtues were imputed to the different gems. For example, the emerald was a protection against poison. The agate acted as a charm against scorpions and spiders; the ruby was thought to protect one from bad dreams; the amethyst prevented intoxication; and the jasper was particularly prized for amulets, and we have the authority of Dioscorides that the figure of Hercules engraved on a certain Median stone, and worn as a ring, would cure the colic.

We read of the rings of Helen and Ulysses, of the legendary ring of Gyges, which were probably engraved stones, and of the signet emerald ring of Polycrates, king of Samos, which was thrown by him into the sea to ward off some impending evil, and kindly brought back by the fish served up to him at table.

It is said that Ptolemy V. gave his portrait engraved on a valuable emerald to Lucullus; and Cleopatra, who was rather inclined to extravagance in many ways, had a splendid stone carved with the head of Bacchus, among her treasures. Of celebrated gems we may speak of the signet of Michael Angelo. It is a carnelian, and great difference of opinion has existed respecting the subject engraved upon it. "By one it is supposed to be Alexander the Great represented as Bacchus, by another it is thought a religious procession of the Athenians, and there are others who suppose it a vintage scene or sacrificial rites relative to the conquest of India." Others declare that it is no antique at all, but that it was engraved by an intimate friend of Angelo. If it has come down from the time of Alexander it is one of the most interesting relics of antiquity. It was in the cabinet of Henry IV. of France, Louis XIV. frequently wore it as a ring, and it is now preserved in the museum at Paris.

Among the gems in the British Museum, there is a very beautiful head of Medusa cut in relief upon chalcedony, that was once in the Strozzi collection at Rome. It is evidently the work of a great artist.

The ancients seem to have had some secret way of producing with the utmost finish, grace, and delicacy, this miniature sculpture upon hard polished stones. The wheel, with the use of diamond dust, seems to have been first used at the Byzantine period.

The secret of their wonderful success may have been that, combined with a genius for art, there existed a patience which in this age of hasty performance by machinery we seldom find. It is doubtful whether they used lenses and globes filled with water to magnify their work. Some engravers of modern times have equalled many of the ancient artists, except a few of the very best. The modern engravers of gems use a lathe and wheel. The wheel is a very small disc of lead smeared with oil and diamond-dust, made to revolve very rapidly on a spindle, and against it the stone to be cut is steadily held. The polishing is done by a revolving brush and emery powder.

We gain by the study of antique medals and engraved gems a knowledge of many things relating to the customs, manners, dress, weapons of war, and religious ceremonies of the ancients, that historians have thought trivial or have overlooked. Portraits of celebrated kings, conquerors, philosophers, and other distinguished persons are preserved in intagli as perfect as on the day they were cut. The history of ship-building is written on medals. The history of architecture is illustrated by them. They are unique art studies. Raphael and Rubens collected them for the lessons they could give. The wonderful genius of the Greeks for sculpture is known to us not more by the Laocöon and the friezes of the Parthenon than by the exquisite work of Pyrgoteles and Dioscorides.

The most eminent modern rival to ancient excellence was the late Mr. J. S. Wyon, an artist of great promise, who had attained considerable eminence at an early age. He was but twenty-two years old when he received the appointment of chief engraver of her Majesty's seals. His father, Mr. Benjamin Wyon, and also his grandfather, Mr. Thomas Wyon, held the same appointment. Mr. Benjamin Wyon superintended the artistic education of his son, who also studied at the Royal Academy of Arts, where he won two silver medals—one for a medal die and the other for a model from life. A medal of James Watt, the inventor of the steam-engine, was his first important work. Robert Stephenson, the engineer, was so well pleased with it that at his suggestion it was made an annual prize of the Institute of Civil Engineers.

Among the most important works of Mr. J. S. Wyon we may mention two medals ordered by the City of London, one to commemorate the arrival of the Princess Alexandra and her reception by the people as the promised bride of the Prince of Wales, and the other as a memorial of the visit of the Sultan of Turkey to the City in 1867.

The Great Seal of England now in use was made by him soon after his appointment, and the Great Seal of the Dominion of Canada in 1867. These are among the most finished productions of his genius. He executed another medal for the Canadian government in the year 1867, in commemoration of the union of the four provinces in one confederation. Several well-known medals of the Royal Family are his work, and are fine examples of his style as a sculptor in this difficult branch of art. He was a juror in the London Exhibition of 1862, and he and his brother, forming the firm of J. S. and A. B. Wyon, received the only medal awarded to British exhibitors in the class of sculpture at the Paris Exposition of 1867. The brothers received two medals at the late Vienna Exhibition. The Sultan of Turkey decorated Mr. J. S. Wyon with the order of the Medjidie in token of his appreciation of the Sultan medal.

In all works of benevolence he was prominent, and his character as a man and a Christian was without blemish. Born on the 28th July, 1836, he expired on the 12th of August, 1873, and his untimely death was and is still lamented by the entire circle of his acquaintance.

The Zoological Society medal, representing beasts on one side and birds on the other, and executed by Mr. Benjamin Wyon, is a fine work. The Royal Botanical Society medal, by the same artist, is, if possible, even finer. We see the palm, the aloe, and the spreading English oak, as in a miniature painting. A medal struck for the City of London School, also the work of Mr. Benjamin Wyon, is very elaborately done. It is covered on one side with Shakesperian figures. Cardinal Wolsey represents the Historical plays; Prospero and Ariel the Pastoral; Lady Macbeth stands out in a very tragic attitude, with her two drawn daggers; and Comedy has a representative in Falstaff sitting in an armchair and showing Prince Hal how to play the king. The three feathers of the prince are perfect, and the fleur-de-lis and the English rose, repeated on his robe, are so minute as hardly to be seen with the naked eye.

The Wyons have been celebrated engravers of coins and medals since the reign of George III. William Wyon executed a coinage for the island of Ceylon in 1821. In 1825 there were several British coins modelled by him, and in 1830 he engraved several pieces after models by Sir Francis Chantrey.

Thomas Wyon was Master of His Majesty's Mint, and designed and engraved the Waterloo and Trafalgar medals.

The Messrs. Wyon of Regent Street keep all the prestige of the name, and are first in their art. They are unsurpassable in their engraving on stones for seals, and their monogram and crest work is noted for its beauty. They have made many seals for universities and for foreign and colonial governments, and one of their latest works is a beautiful seal for the newly-acc[illegible] of Fiji.

Engineering, Building, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, &c.

§ 1. *Engineering.*

FIRELESS Locomotives.—New Orleans is now connected with the suburbs by a line of railway worked with fireless locomotives. These consist each of a hollow cylinder of boiler-plate 10 ft. long and 4 ft. in diameter, which is kept half filled with water, and rests on a frame provided with four wheels. A double vertical engine is placed at the end of the cylinder next the train within reach of the conductor. At one of the termini the cylinder is filled, from a stationary engine, with sufficient steam to supply the engine during the journey out and back. The working expenses are said to be less than those of a horse or mule railway. A locomotive of this description costs £250, inclusive of the royalty to the inventor. *Revue Indust. 23rd June*, 1875.

Use of Talc in Steam Boilers.—MM. VIGIER and ARAGON recommend the use of talc as a preventive of scale. The Lyons and Mediterranean Railway is stated to employ the method extensively, and with excellent results. The quantity of talc placed in the boiler at once is about one-tenth of the weight of the solid deposit produced by two successive washings of the boiler. Not only is the formation of scale prevented, but that already formed becomes gradually detached and carried away. This is a novel and interesting application of a cheap and abundant mineral, which has many curious properties, but hitherto has not been turned to much industrial account. Talc mixed with paraffin and some sort of fibre is now beginning to be used for boiler-furniture, and is stated to have special advantages. *Moniteur Indust. Belge, 20th June*, 1875.

New Composition for Bearings.—M. COLINÉ recommends a composition of certain materials—bad conductors of heat—for the bearings of machinery and wheeled vehicles of all sorts. He mixes 3 parts of asbestos and 1 part of black lead together, after pulverizing them well, adding a sufficient quantity of the soluble silicate of soda or potash to form a semi-dried cake. This cake is converted into a hard mass by hydraulic or other pressure, and afterwards dried with heat or by exposure to the air. It is then turned in a lathe to the required pattern of bearing; or the paste may be pressed in a mould to the desired shape, and dried afterwards. In either case, the bearing should be well soaked with paraffin or some mineral oil, so that the pores of the composition may be filled therewith, before use. *Moniteur Indust. Belge, 20th June*, 1875.

Preservation of Locomotive Tires.—M. F. A. VON SCHULZ-STRAZNICKI, engineer of the Kaiserin Elisabeth Railway, calls attention to a method of reducing the wear and tear both of locomotive tires and rails, which has been tried with signal success on the Budweis-St. Valentin branch of that line, where are numerous curves of 300 metres radius and gradients of 1:80 to 1:65, and also on the Lambach-Munden small-guage branch line, where are curves of 75 metres radius, with like gradients. The method consists in the lubrication of the tires with a composition prepared by L. Artmann, at the suggestion of a well-known Austrian engineer, M. Fisscher von Rösslerstamm. This lubricant, which has the properties of mutton fat, without its greasiness, and a melting-point that never exceeds 167° Fahr., is manufactured by the aforesaid maker under the name of "Hartfette," and is moulded in the shape of tablets 5 in. long, 2 in. broad, and ½ in. thick, numbered in three degrees of hardness, Nos. 0, 1 and 2, to suit the temperatures of different seasons.

A box formed of a couple of iron plates, connected by wooden sides and open at the ends, is fitted over each wheel; and in this a lubricating tablet is placed, resting, by one of its narrow ends, and by its own weight, against the flange of the tire. If increased lubrication is desired, the pressure may be increased by wedging a piece of wood or another tablet in the box for that purpose.

Under ordinary circumstances one tablet will serve for a run of 500 to 800 kilometres (300 to 500 English miles).

The cost on lines where, owing to the frequency of the curves, the friction and consequent wear and tear is greatest, does not exceed ·066 Austrian kreutzers per locomotive for each kilom. run, even in the hottest summer weather. The average of the whole year does not exceed ·026 kreutzers per locomotive per kilometre.

The advantages of the arrangement, detailed figures of which will be found in the undermentioned journal, are that it is cheap and simple, and can be applied or not, as the weather or other circumstances render desirable; its application is within the comprehension of the humblest capacity; it does not interfere in any way with the bite of the wheels on the rails, or with any modifications that it may be considered desirable to introduce in the material or design of the rolling stock. It is applicable to the wheels of any description of rolling-stock, as well as those of locomotives.

The saving thus effected in the wear and tear of the rails is stated to deserve more careful consideration than it has yet received.

Artmann's "Hartfette" is sold in Vienna at the following prices:—

No. 0, for winter use	. .	1·00 florin per kilo.
„ 1, „ medium use	. .	1·40 „ „
„ 2, „ summer use	. .	1·60 „ „

The same material is also prepared in two higher numbers, under the name of "Nothfette," for the lubrication of axles and bearings of all kinds. These sell at the prices below specified:—

No. 3, soft	. . . .	1·80 florin per kilo.
„ 4, hard	. . . .	2·00 „ „

Zeitschrift des Ingr.- und Architekten-Vereins, No. 10, 1875.

Mechanical Separator.—This apparatus has been devised by two French engineers, MM. AULIER and ALLAIRE, to obviate the difficulties frequently experienced in the filtration and decantation of liquids in industrial processes.

It consists of two cylindrical vessels—the outer fixed and provided with stop-cocks at suitable heights; the inner one of much smaller dimensions, revolving on its own axis, and provided with a separate escape-pipe at the bottom. The liquid to be purified is received in the inner vessel, which is made of sheet tin, copper, or other metal, with numerous longitudinal slits. This is made to revolve about its axis, and the solid particles suspended in the liquor with a certain quantity of the latter, are carried by the centrifugal force so acquired through the slits into the outer vessel. The purified portion in the inner vessel is run off through the escape-pipe at the bottom, when it is considered that the process has been carried far enough. The rest of the liquor, with the suspended impurities, is allowed to settle in the outer vessel, and can be run off at different levels, according to the degree of purity required. Paper-making and sugar-manufacture are cited as industries to which the apparatus will be found peculiarly advantageous. *Technologiste, May*, 1875.

§ 2. *Building, Decoration, &c.*

Staining in Imitation of Walnut-wood. Deal and other common woods are stained to imitate polished walnut in various ways. One method is, after careful rubbing with glass paper, to go over the surface with a preparation of Cassel brown boiled in a lye of soft soap and soda. After drying, the surface is rubbed over with pumice and oil, and polished with shellac. Others use instead a decoction of green walnut-shells, dried and boiled in the same lye or in soft water, to which soda has been added. Others, again, employ catechu and chromate of potash in equal parts, boiled separately and afterwards mixed. Various other preparations are also used. All to some extent accomplish the desired purpose, but none are free from objections. The Cassel brown will not take equally well on all kinds of wood, so that if not laid on thick, it sometimes comes off under the subsequent pumicing, whilst on the other hand this same thickness conceals, more or less, the grain of the wood beneath, giving it the appearance of having been painted. The decoction of walnut shells is apt to come off on the clothes as a yellowish adhesive substance. The mixture of catechu and chromate of potash leaves a reddish brown deposit on the surface of the wood, very unlike real walnut. The best method appears to be the following:—Walnut-shell extract 1 part (by

weight) is dissolved in soft water 6 parts, and slowly heated to boiling until the solution is complete. The surface to be stained is cleaned and warmed, and gone over with the solution once or twice. When the latter is half dry, the whole is gone over again with 1 part of chromate of potash boiled in 5 parts of water. It is then dried, rubbed down, and polished in the ordinary way. The process is cheap and effective. The extract of walnut-shells and chromate of potash are procurable at any large druggist's establishment. *Gewerbehalle, No.* 7, 1875, *from N. D. Gewerbe-Zeitung.*

Iron Varnish.—Dr. WIEDERHOLT, of Cassel, gives this name to linseed-oil varnish prepared by a particular process, the result of experimental researches which have occupied him for many years. He asserts it to be the best material for covering iron surfaces of all kinds, as a protection against atmospheric influences. It unites the advantages that preparations of linseed oil are admitted to possess in such cases, together with extreme fluidity, allowing it to be applied, quickly and evenly, in a single thin coat, to any kind of surface, and remarkable drying powers, so that without the assistance of heat or the addition of any sort of drier, it hardens quickly enough to be unaffected by diurnal variations of temperature, which, by producing a deposition of atmospheric moisture in contact with exposed surfaces, not unfrequently impede the perfect settling of ordinary varnishes. *Industrie Blätter, 24th June,* 1875.

Cement Marl in Moravia.—A bed of marl, 1,036 acres in extent, 1·6 to 2·5 metres thick, exists in the neighbourhood of Marschowitz, in Moravia, close to the surface, being overlaid by 16 to 32 centimetres of humus only. Attention was called to the suitability of this marl to purposes of construction, in "Die Bauhalle" for 1873. Later experiments have confirmed this view. According to Professor Carl Zulkowsky, the composition of the marl, at the depths specified, is as below :—

	0·95 m. below surface.	1·9 m. below surface.
Water	2·68	1·87
Silica	54·17	59·52
Alumina	10·68	11·39
Iron oxide	3·63	4·57
Carbonic acid	9·85	7·19
Lime	11·93	8·53
Magnesia	2·47	2·40
Potash	2·25	2·23
Soda	1·36	1·89
Organic matters and loss	0·98	0·41

Sealed samples of the least promising portions of the deposit were lately sent to Vienna for experiment, and were burned into cement, with an admixture of limestone from Knömtz, distant about six English miles from the marl beds. Two stones with surfaces of ·312 square metre, were cemented together, face to face, with the best Perlmooser cement, and left to "set" for two months. Two similar stones of equal weight were then treated in like manner with the marl cement. The stones were hoisted by cranes, and the lower ones weighted until they separated. Those united with best Perlmooser cement parted under a weight of 10·7 tons, or 3·4 kilogrammes per square centimetre. Those with the marl cement required a weight of 9·64 tons, or 3·1 kilogrammes to separate them, although the quality of the marl was not the best, and the cement had only been allowed one month to set, in place of two. The experiment was held to be conclusive in favour of the utility of the marl for the purpose indicated. *Zeitschrift des Ingr.- und Architekten-Vereins, No.* 10, 1875.

Cheap Black Lacquer for Ironwork.—Finely powdered asphalte, dissolved in spirits of turpentine, and laid on thinly with a paint brush, will be found a cheap and serviceable lacquer for ironwork of various kinds. It dries quickly, and looks well. *Bayerisches Indust.- und Gewerbe-Blatt, from Töpfer and Ziegler-Zeitung.*

THE HARVESTING AND STORING OF GRAIN.

I.

AT all times it is best so to arrange work, much of which from the necessities of the case has to be done under circumstances which may cause loss both of time and material, that one may be prepared for the worst; but it is specially wise and forethoughtful, if one may coin a word for the nonce, to arrange for this when there are around us indications of a somewhat too certain character that this "worst" will happen. The present time seems to be one of those occasions; at all events there is enough in the condition of the season to convey warning to thoughtful minds. And, beyond all doubt, it is difficult to gainsay the statement that as there is nothing so valuable to a people as the food upon which it depends for existence, so there should be nothing so important to their interests as means by which such food should be so dealt with by all classes that none of it shall be wasted. The proverb tells us that waste brings want; but if the waste be brought about by carelessness or indifference, the waste becomes "wanton," and the want may well then be, as it often is, alike in the history of peoples, as of individuals, "woeful."

In dealing with the food which our own fields produce, it is obvious that the first work of dealing with it, either carefully or carelessly, rests with the farmer, and that too much of the dealing comes under the second category is a matter unfortunately of too much truth.

As the whole subject involved in our title carries with it points of the most vital importance, it will not be using one or two of our pages amiss if we glance at its leading details. And in doing so, it will be best to begin at the beginning, and to inquire whether there be not some means at the command of the farmer by which, while even in the field, he can prevent the action of continued or intermittent but soaking rains upon his grain; or, at least, if not to prevent to greatly modify and lessen their evil effects.

That in the department of putting up grain in the field there are two ways of proceeding, a bad one and a good one, there can be little doubt, just as we find, in fact, that these characteristics prevail in other departments as well. And it takes no great degree of observation, in examining the practice of various districts throughout the kingdom, to see that there are bad and stupid as well as good and wise methods of drying the cut grain while it stands in the fields. We have seen, for example, in a district—certainly by no means celebrated for its high or good farming—corn put up in the field in such a way that if the object was to make it as exposed to the effects of rain as it could possibly be, the plan adopted was admirably calculated to secure this absurd end. Nothing, indeed, can exceed the carelessness with which some farmers put their corn up—sheaves carelessly bound, and put together in the stooks, so placed that the rain found the earliest possible entrance to the grain, and yet so disposed that the drying winds could not pass easily through the bulk; for days the "rattling showers come in the blast," and yet the farmer will not enter his fields once to see if any adjustment of the stooks in it could be made to better secure them from the entrance of the rain; sheaves by the dozen will be prostrated by the wind, and will be allowed to lie for days exposed in such a way, as if the rain was as welcome as the drying sunshine; while to prevent all this—which no one surely will maintain to be good practice—a few hours, possibly a few minutes, of the work of active hands, aided by an intelligent quick eye, would put things on a different footing. Stooks, too, with the most reprehensible carelessness, will be placed in hollows, where, during heavy rain, their bases will be sure to be standing in soaking wet. We have seen frequently stooks standing in pools where, not a few yards off, there was unoccupied ground at a higher level, on which they might have stood clear, *at least*, of the evil effects of *standing water*. All the plans of working, by which stooks could be properly built, so as best to secure them from rain, and by which, when heavy winds have more or less disturbed in this the safe arrangement, they can be readjusted and made as "taut"—to use a sailor phrase—as possible, come, of course, under the category of things that may be done, and not seldom under that of things that are never done. It does not come within the province of the present part of our paper to discuss the various modes of stooking corn in the field, but we may observe that the proper and effective hooding or topping of the stooks should be rapidly carried out; the good effect of a good hood or top in warding off the rain, and causing it to shed off the rain on either side, dropping on the ground in place of soaking into the mass of grain, cannot be over-estimated, so important is it. In some parts of the kingdom small *stacks* or ricks are made in the field, and with remarkably good results in bad and rainy weather. When this plan is adopted the rick or waterproof cloth cover will come into operation very usefully, and certainly, in such a case, cannot be objected to as Utopian and impracticable. It has been used with excellent results in such cases. Although we have sometimes in this "weeping climate" of ours—as it has been more or less justly designated—successive days or hours of heavy, pitiless rain, we have often what is called changeable weather, in which alternations of sunshine or of shower are met with. Where the shower is off for some time, and of course the weather wisdom of the farmer will aid him in deciding whether this is likely to be the case or not, it will not be lost time if the men or women are sent into the fields to take

off the top or hood of each standing stook, exposing the grain of the standing sheaves to the sunshine or the breeze, and by laying the hood sheaves properly on the ground to allow them also to get well dried. Of course this will take time and involve trouble, but where these are grudged, where the work to be done is good work and which ought to be done, no more need be said. A farmer who is careless of the results of indifference, or, not to put too fine a point upon it, of laziness, deserves to lose his corn or find it quickly deteriorated in value; certainly he deserves no pity, and should get none. Pity he is sure to get, if not something more substantial, if, at the end of an untoward season, he can say, "I have done what I could to mitigate its evils and modify its results." When he has done his best in this way nothing more is to be said, but we are well aware that in some districts in wet seasons, such as many we have passed through or are now in some districts passing through, farmers have not done their best, have indeed done nothing at all; while we believe that if that best had been done, much of the evils of the season would have been avoided.

It is indeed surprising, nay, it is painful, and very much calculated to give pith and point to the sayings of those not connected with agriculture as a pursuit, who designate farmers as being amongst the slowest of the slow; we say it is surprising to see how, day after day, some farmers will be content to look upon a state of matters in their fields or in their folds which are the source of great loss to them, and which a little energy and intelligence would enable them greatly to modify, if not, in some cases, wholly to prevent. How often, indeed, is the pithy proverb, with all it teaches, forgotten: "For the want of a nail the shoe was lost, for want of a shoe the horse was lost, for want of a horse the rider was lost." It is a pity that in much of farm practice the connection between the nail and the rider is so often overlooked.

There are, we repeat, two modes of drying cut corn in the field—the good and the bad way; and there can be no doubt of this, in the minds of those who know the practice of a wide variety of districts, that in too many instances the bad way has been adopted, and the results of the rainy season have been all the more unfortunate. The farmer cannot avoid bad seasons any more than the sailor can avoid storms, but it is in the power of the latter, as, indeed, it is exemplified in his practice, to prepare for storms and mitigate their effects accordingly, so we maintain it to be greatly within the power, by judicious arrangements and by the exercise of never-failing energy and watchful prudence and industry, to mitigate the evils of untoward seasons in that department of his practice now under consideration. As before stated, the whole subject is one of the most vital importance to us as a nation, and although the treatment of its details may not at first sight be supposed to be interesting, except to those directly engaged in the practice of agriculture, we trust to be able to show, in the few paragraphs to be given in a succeeding number, that there is much connected with it that is interesting to general readers, and worthy of the attention of those, specially, who study the pages of a magazine so eminently devoted to all that is *practical* as ours is.

COATING IRON AND STEEL WITH COPPER.

IN the "Moniteur Industriel Belge" of the 1st ult. a good deal of interesting information on this subject is afforded by M. Gaudouin, of the well-known establishment of Gaudouin, Mignon, and Rouart, iron-founders, of Val-d'Osne, together with some details of certain processes lately patented by that firm.

M. Gaudouin states that the oldest method of coating iron with copper is that of M. Ruolz, in which a double cyanide of copper and potassium is decomposed by a powerful electric current. This answers with very pure iron and when the surfaces have been thoroughly scoured, but the coating of copper so produced will not stand working. Common kinds of iron, and cast-iron particularly, are too full of irregularities and impurities of all sorts to allow of the perfectly uniform deposition of the copper, and any point not so covered speedily rusts. If a thicker deposit is essayed with sulphate of copper in an acid bath, the acid penetrates the copper skin and destroys its coherence with the iron beneath. The cyanides are expensive and do not keep well, and a very powerful current of electricity is requisite, so that the process is costly and is used only for small objects.

In M. Weil's process the alkaline liquor is sulphate of copper dissolved in an excess of tartrate of potash and soda, alkalized with caustic soda. Wrought or cast-iron objects, after scouring, are immersed in this bath by suspending them with zinc wires. The dissolution of the zinc in the bath develops electric action, but the bath always contains more zinc than copper, and needs frequent renewal. The deposit is very thin, and has a granular appearance with iridescent patches caused by partial oxidation of the copper. The deposit is very thin, and too slight effectually to protect iron surfaces, as the scouring of the latter is never complete in practice.

All processes for the deposition of copper with the aid of alkaline liquors have this disadvantage. M. Weil's method is cheaper than that of M. Ruolz.

M. Oudry covers cast-iron with a preliminary non-conducting coat of red led and some resinous substance or substances, blackleaded over. An acid bath of sulphate of copper can then be employed without fear of injury to the iron. To give solidity to the copper skin, he uses a certain thickness, 1 millimetre or more. Taking into account the thickness of the underlying coats of red-lead and plumbago, it will be apparent that the method is only applicable to objects of large dimensions. The fountains in the Place de la Concorde and the Place Louvois, and the candelabra in the Paris Boulevards, are bronzed by this method.

To simplify the process, M. Oudry, junior, replaces the preliminary coating of non-conducting material by an immersion in boiling oil holding powdered copper in suspension. On coming out of this bath, the objects are stove-dried and brushed over with wire brushes and copper dust. They are then treated in an acid bath of copper sulphate in the ordinary way. The oil here acts as a non-conducting varnish; the copper dust takes the place of the plumbago. No adhesion is possible between the iron and the galvano-plastic outer coat, separated as they are by a layer of fatty substances.

The process employed by M. Oudry, senr., is unwholesome, as it involves the use of red or white lead. That of M. Oudry, jun., is still more so, as the objects have to be brushed over with copper dust, certain quantities of which necessarily enter the lungs, and are eminently injurious.

From what has been said, it will be understood that it is easy enough to produce a deposit of copper on surfaces of wrought or cast iron or steel, but very difficult to give to such deposit thickness, continuity, and adhesibility to the underlying surface of metal, sufficient to protect the latter in a durable manner.

With the aid of his partners, MM. Mignon and Rouart, M. Gaudouin has made trial of an immense variety of processes, of which three have been found to give very satisfactory results. These are described below; and it is claimed for them that they stand alone as means of producing a really adherent deposit of copper on surfaces of cast and wrought iron and steel, at a very moderate cost.

1st Process—Dry Method.—When the design is to produce a deposit of copper, bronze, brass, &c. on an iron surface, without such deposit being perfectly uniform throughout, as in the case of cylinders for colour-printing, the bearings of machinery, large-sized valve-cocks, &c. sufficient metal for the purpose is run down in a crucible of suitable size and shape; then, after the surface of the molten metal has been covered with a flux composed of cryolith (double fluoride of aluminium and sodium) and phosphoric acid, the object to be coated is immersed in the bath, after a preliminary heating to the temperature of the latter, and in such a way that the molten metal may be in contact with every part of it at once. If the object to be coated is wrought-iron, borax may be substituted for the flux; but if it be cast-iron or steel the flux described above is indispensable, as borax exerts no cleansing action upon their surfaces.

The process may be facilitated by the adoption of the following arrangement. A charcoal vessel in the form of a semi-cylindrical trough is fixed in a horizontal position, in a suitable furnace; in it is placed the copper, brass, or other metal to be deposited, and the flux which, being lighter, floats at the surface of the molten metal, preventing its oxidation, and cleansing the metallic surface on which it is to be deposited. The object to be coated—as for instance, a printing-cylinder—is suspended over the trough, and partly immersed. When the metal has been brought to a suitable temperature, the cylinder is slowly turned on its axis, to bring every part into contact with the molten metal, which quickly unites with it.

The deposits so produced are absolutely adherent, and the coated surface may be worked up afterwards to any shape or form without fear of the deposit being detached. It appears extraordinary that so simple a method should not have been discovered long ago; but it must be remembered that two formidable obstacles had to be encountered—the manufacture of charcoal vessels capable of resisting the destructive action of the flux above described, and the discovery of the flux itself, the only one capable of effectually scouring a cast-iron surface.

2nd Process.—Precipitation by the Dry Method, with or without the aid of an Electric Current.—This process is applicable to moulded articles, requiring a thin coating of copper only. In a crucible or charcoal vessel, 1 part of chloride or fluoride of copper is run down with 6 parts of cryolith, a little chloride of barium being added, if required, to increase the fusibility of the mixture. These proportions are not absolute, but may be varied within pretty wide limits. When the metal is in a state of perfect fusion, the object to be coated, whether wrought or cast iron, or steel, after a preliminary scouring, is immersed therein, and by its affinity for the copper separates the latter, and appropriates it as an adherent skin, the thickness of which is proportionate to the duration of its immersion and the degree of concentration of the bath. A current of electricity, the negative pole being connected with the object to be coated, and the positive with the copper in the bath, facilitates the formation of the deposit. Or, a copper crucible may be employed, so as to form part of the electric current. Other cuprous salts, with or without an admixture of cryolith or other alkaline or earthy-alkaline salts, would perhaps give analogous results; the speciality of the process is the decomposition of the cuprous salts, whilst in a state of fusion, whether alone or in combination with other salts, by chemical affinity or electric action.

3rd Process—Wet Method.—Many have been the attempts to obtain a thick, adherent, and continuous coat of copper upon iron and steel surfaces, by the use of various cuprous salts, both alkaline and neutral, in a state of aqueous solution, but without success. The secret of this unsuccess has been that the surfaces, those of cast-iron more especially, have not been thoroughly cleansed, and that the baths employed have been chemically unsuited to effect such scouring completely.

In coppering cast and wrought iron or steel for industrial purposes, a highly acid solution is requisite, which shall be capable of dissolving the iron oxides that have escaped the scouring process, without injuring the subjacent metal. Such a solution acts steadily at the points where the copper is not yet deposited, eating away the rust that interferes with its deposition. A high degree of acidity in the solution greatly improves the physical characteristics of the deposit, which becomes adherent, ductile, and malleable, and, by reason of its great conducting power, requires a less expenditure of electric power. Many organic acids, chiefly the polybasic acids, as tartaric, oxalic, succinic, citric, malic acid, and others which have analogous properties, combined with cuprous oxides and with alkaline oxides in the form of double acids, as in the alkaline bi-tartrates, bi-oxalates, quadroxalates, bi-succinates, bi-citrates, bi-malates, with the corresponding cuprous salts and an excess of acid, where they do not act too powerfully on the iron, are well adapted to produce a good deposit. A temperature of 40° to 60° C. assists the operation. An electric current is necessary when a thick coating of copper is desired. The application of the electric current, and the preliminary scouring of the iron need not be described, as they are not peculiar to the process under consideration.

With the aid of these baths, wrought or cast-iron and steel surfaces may be coated with alloys of copper and tin, or copper and zinc, or copper and aluminium (aluminium bronze). It is only necessary to mix with the copper baths, above described, a suitable bath of tin, or zinc, or aluminium, the quantity used being in inverse proportion to the electric conductibility of the two baths, and to employ soluble anodes. Or the same results may be attained by employing a soluble anode of bronze, brass, or aluminium bronze; or better still, of tin, zinc, and aluminium in a copper bath, taking care to proportion the electric tension to the superficies to be covered. This is essential to the success of the operation, as too weak a current acts on the copper alone, and one too powerful affects the other metals preferably.

M. Gaudouin's concluding remark, that all three processes require an intimate knowledge of electro-chemical manipulation, and that practice teaches many minor details, too minute for cursory description, which nevertheless are of essential importance, will readily be understood by our readers.

The "Moniteur Industriel"[1] adds, that many thousand tons of cast and wrought iron and steel have now been coated by these processes. The colour of the deposit is unexceptionable; its depth is uniform, in the deepest depressions and on the most prominent portions of the surface alike. So great is its adhesiveness, that, when removed with a cutting-tool, portions of the cast-iron beneath are observed to come away with the copper. It weathers well. Objects thus coated have been exposed, out of doors, for eighteen months, and have stood a winter and two summers without the slightest symptoms of change. Cast-iron objects are not more than doubled in price by the process, so that the full effect of bronze may be attained at less than two-sevenths of its cost. A couple of statues of bulls larger than life-size, and weighing 1,600 kilogs. (30 cwt.) each, are now undergoing a process of bronzing in this way. The bath is found to keep well, and after seven months of use, day and night, it gives as good a deposit as at first.

The firm are understood to have applied the same process of electro-chemical deposition to the tinning of cooking utensils and other iron goods with great success.

[1] See "Moniteur Indust. Belge" for 10th April and 1st July, 1875.

CHEAP FLAT ROOFS.

HISTORY has handed down to us the high perfection attained by most of the oriental nations in the construction and laying out of their roofs. The care which was bestowed on this architectural portion is of long standing, for we find already the patriarchial law, "When thou buildest a new house, thou shalt make a battlement for the roof, that thou bring not blood upon thine house, if any man fall from thence," in Deuteronomy xxii. 8. Again, the roofs of the oriental nations served various purposes; they were used as drying grounds, or for bleaching. People met there to look upon passing festivities, or they were used as platforms for public speakers. Gardens, with sweet smelling arcades, grottos, fishponds, or baths were tastefully laid out on the tops of the houses, and these summer-houses served likewise for sleeping or dining rooms. Our chief admiration has, however, been claimed by the luxury expended on the hanging gardens of ancient Babylon and Persepolis, as described by Herodotus. Even at the present day our travellers return from these parts filled with amazement at the comfort and beauty of these oriental roofs. The wide, extensive view, the refreshing breezes, coupled with all the available comforts which the oriental mind is ever ready to adopt, render the roofs objects of delightful recreations and sweet recollections.

It is true that the oriental climate is much the cause of this roofing construction, but there are not many reasons why, in many cases, a flat roof should not be here introduced and developed in a similar manner. We apply this remark especially to those classes of houses known under the name of "workmen's dwelling-houses." Much has been said and written on this latter subject, and perhaps at no other period of the world's history has so much been done to improve the workman's home as has been achieved in the century we are living in. The satisfactory solution to this problem is evidently in erecting a house with the greatest amount of healthy comfort in the least corresponding plot of land, for in these days of expensive ground, it is needless to remark that large house-grounds must necessarily enhance the rent in a similar proportion, thus placing certain restrictions or maybe impossibilities in the way of the would-be tenant. Consequently, any devisable means, whereby the recreative home pursuits of the working-man might be extended, without placing higher rents to his burden, must prove welcome items.

A step in this direction is evidently in the utilisation of the roof for such purposes as those alluded to in the various uses to which it is even at the present time subjected in eastern countries, and it is on this topic that we would now request the attention of the reader. Flat roofing was already practised by the Assyrians and Babylonians, who, as we read, constructed their roofs almost on a horizontal level, by applying layers of fibrous substances, covering these alternately with resinous matter, and recovering the whole with earth, sand, or gravel, &c. A similar method has been practised in Norway from the remotest times, inasmuch as the slightly inclined roofing spars may be there found to be covered with resinous layers mixed with birch bark, and subsequently covered with earth and grass-clods. At Trevelez, near Malaga, at a height of 8,500 ft. above the sea, a similar roofing construction has been adopted since 1470. Here in England, as in Germany, steep inclined roofs were generally introduced, and we therefore possess no ancient records bearing on a similar construction; but from the foregoing brief summary it is evident that the manner in which this horizontal roofing was treated, left much to be improved, besides being dangerous in the extreme.

It was in the year 1839, that a Silesian merchant (Carl Samuel Hausler) invented a roofing cement, which he first applied to eight of his own houses for horizontal roofing, and which he subsequently extended to other houses, after having allowed years to elapse to test the merit of his invention. The oldest roof which he constructed according to his own idea, may be found at some works near Hirschberg (Silesia), which has now

stood *twenty-three* years' wear and tear, without requiring any repairs whatever ; it was covered with six inches of earth, which was used for meadow land, and produced according to our accounts a splendid vegetation.

After such satisfactory results, Hausler largely extended the application of his roofing cement. The Prussian government took the matter up, and ordered the composition to be put to fire and water tests ; as a result of these experiments, the committee appointed reported on the 17th June, 1850, that "Hausler's fire and water safe roofing cement had not suffered in the least during a period of between four and five years." At the end of 1859, the Provincial Fire Insurance Company of Breslau resolved to classify all roofs covered with this cement as fireproof. But perhaps the greatest success, which however the inventor did not live to hear, was the resolution the Saxon government arrived at, after having subjected Hausler's roofing cement to a fire-test lasting several hours. Hitherto cement roofing had been prohibited by the Saxon government, through a law passed on the 29th September, 1859, but as a result to the previous experiment a decree of the 16th September, 1862, allowed the use of Hausler's roofing cement in the whole kingdom.

Owing to the fire and water resisting properties of this roofing cement, it has been largely introduced in bridge constructions, and for fortress works, and its special adaptability to garden purposes has likewise introduced it in many of the continental cities, where it serves the double purpose of sheltering the house-occupants from an overwhelming heat in summer, and from a piercing cold in winter. It has not merely been recommended on these grounds, but a series of experiments have likewise proved it, from an economical point of view, to be the cheapest roofing on the continent, as the following summary, including cost of material and workmanship, readily shows :—

Roofing one square meter (39·37 square inches) with

Hausler's roofing cement costs approximately			10·2	shillings.
Slates	"	"	11·4	"
Zinc	"	"	15·5	"
Tiles	"	"	12·1	"

But the chief advantages which are claimed for this roofing cement are :—

1st. It may be applied almost on a horizontal surface, requiring only a slight gradient of 1 in 16 or even 1 in 20.

2nd. It dispenses with complicated roof constructions, and requires no spars, thus saving a considerable amount of carpentering, besides requiring less masonry and shorter chimneys.

3rd. It is thoroughly water-proof and is of great durability, provided it has been properly laid on. The roof-covering forms one complete surface, without any joints whatever, thus preventing rain or snow from penetrating through it, and enabling gardens to be tastefully laid out on its surface without impairing its durability in any form or manner. It ensures a cool temperature in summer, and retains a warm atmosphere in the interior of the house in winter time.

4th. It affords commodious room immediately under the roof, and as the cement is a very bad conductor of heat, this space is rendered tenantable.

5th. Utilisation of the roofing-surface for domestic and trade purposes, such as for vegetation, bleaching, or drying, &c.

6th. It offers an advantageous situation for firemen in cases of adjacent fires breaking out by affording them a better position to stand in.

7th. It cannot be damaged by stormy weather or be set on fire by flying sparks, and is, in fact, fire-proof.

8th. Lastly, as we have seen, it is cheaper than either zinc, tile, or slate roofing.

As is the case with almost every worthy invention, Hausler's roofing cement has been much infringed upon by spurious imitations, and to this reason the cause may be attributed that it has fallen into discredit amongst certain users, who by buying cheap inferior imitations found themselves deceived in the article. Hausler gave the name of *Holz-cement*[1] to his compositions, and the inferior article may be mostly discerned under the name of *Dach-cement*.

Since the efficiency of this roofing material greatly depends on the manner it is laid on, we will now proceed to give a description of its proper treatment. The beams, 6 in. to 8 in. thick, are placed at a distance of two and a half to three feet from centre to centre apart from each other, and fixed to the gradient required, being afterwards covered with boarding one to one and a-half inches in thickness. Care must be taken that the entire surface of the boards presents an even surface, without any nail-heads or joints protruding one above the other. It is likewise advisable to nail the boards lengthwise downwards.

Before applying the first layers of paper the boards are strewn and slightly covered with fine sand, so as to completely isolate the roofing composition from the boarding, and prevent the paper sticking to the boards, besides enabling the latter to give and shrink independently of the covering. The roofing cement is heated in a boiling-pan until it becomes liquid, care being taken to prevent its boiling, since the latter temperature would cause it to lose its adhesive qualities.

Strong roofing paper, manufactured in single lengths of from 150 to 200 ft. by 4 ft. wide, is now laid over the sand-surface, beginning with one gutter and carrying it over the crown to the other, and nailing the paper down at the gutter ends to prevent the wind blowing it away. Each strip of paper is allowed to overlap the preceding one by about six inches. The liquid cement is next evenly applied by a soft brush to a width of two feet, corresponding with the width of the second layer of paper, which is pressed smoothly on to the composition by means of a second workman, who unrolls a second paper-roll immediately where the brush has passed, and presses the paper softly down with the palm of his hand. The first strip being laid down, the remaining surface of the second layer is finished similarly with full-sized paper, allowing four inches for overlapping. Precisely in the same manner a third and a fourth layer of paper is applied, beginning again with full-width paper in the third and half-width paper in the fourth layer, in order to retain a smooth surface throughout.

A *sine qua non* in this kind of roofing is, that the work must be done neatly without any creases, and the pressing of the paper on the prepared surface ought to be done immediately after the brush has been applied, in order to effect a more perfect and durable combination. Again, the workman should be made to wear slippers made entirely of cloth or some such material, since their ordinary nailed boots would greatly damage the roofing in its various stages. Mishaps or damages should be repaired by little strips of cemented paper before applying the succeeding layer of paper over the damaged portion.

The zinc gutter is fixed on to the second layer, allowing four to six inches as lap, and angle zinc pieces likewise fixed on to the gable-ends of the roof on the same layer. Chimneys, or vertical walls, may be joined to the roofing by zinc plates fixed on to the second layer, due precaution being taken to make these plates sufficiently large, to drive one end well into the masonry, filling it up with Portland cement, and to pay particular attention that the third and fourth layers cover the remainder of these zinc plates neatly and thoroughly. Door traps or low chimneys may be made entirely of zinc.

After the fourth layer of paper has been laid over the whole surface, it is covered with a thicker coating of the roofing cement, and powdered smithy-coal is next evenly sifted on. On the top of this, fine and coarse gravel, to a depth of some two to three inches, are next applied and beaten down level, after which the laying on is completed. The gravel serves to protect the roofing cement, and to exclude the same from the action of the atmosphere.

Having now pointed out the applications and laying on of this roofing cement, and having specially referred to its special adaptability for different purposes, we may conclude our remarks by saying that the merits of Hausler's invention were recognised in this country at one of our London exhibitions, where it received a highly complimentary testimonial. *Brit. Architect, 3rd July*, 1875.

[1] In translating this we think roofing cement is better adapted than wood cement.

FIELD'S "EXPANSION" COMPOSITION FOR COATING STEAM BOILERS.

THE results of some experiments which we have had the opportunity of closely observing, details of which we will give in a future number, incline us to a favourable opinion of this composition. After coating, the boiler experimented with showed an increase in the pressure of steam of 50 per cent., with a reduction in the temperature of the stoke-hole of 40 per cent., the consumption of fuel being reduced by 15 per cent. Beyond its efficiency as a non-conductor it is claimed that the composition, which is of an elastic character, will expand and contract with the boiler itself, and will therefore permanently adhere to the iron ; that it will show any leak, whether of water or steam ; that it will stand the heat of flues ; and that if removed it can be used over again.

NOTES ON THE PAPERS IN THE VIENNA EXHIBITION OF 1873.

By M. Chas. Becoulet.[1]

THE Japanese Exhibition was a very remarkable one. It had been organized by the Japanese Government, who had caused to be collected from the several provinces specimens of the principal kinds of paper manufactured in each. The exhibits included every description of paper made in Japan, from the thinnest and smallest in size, measuring 18 in. by 9 in., and weighing about 7 grains per sheet, which is used for filtering some of the finer varnishes employed in lacquer-work, to the largest, used for Government official purposes, measuring 26 in. by 9 in., and weighing half an ounce each sheet.

All these papers are nearly, if not quite, destitute of size. Most have a rough surface; a few, however, had been faced in the wet stage, and were very soft and silky to the touch. The rough surface is a necessity, as in writing, the Japanese, like their Chinese neighbours, trace the characters with a brush. The paper is made to take and absorb with facility what is commonly known as China (Indian) ink, but which in reality is quite as much in use in Japan. A very remarkable feature in Japanese papers is the length and tenacity of the fibre, which permits of their application to various purposes unheard of in Europe. Japanese paper is used, not only for writing, printing and packing, but for many other objects. It is spun into thread, which interwoven with silk gives a material well suited for summer wear. The same thread gaily dyed or gilt is used for tying up bonbons and fancy goods. A coarse sort of paper, of very firm texture, is dressed with oil, and forms a material resembling waxed cloth. It is used for packing and making waterproof garments. Sheets of this paper glued together face to face, and decorated with coloured designs, make very durable table and floor coverings. Other papers of the same kinds are glued together in several thicknesses and dyed, furnishing a material resembling india-rubber, which is much used for tobacco-pouches, bags, travelling cases, &c. By another process the same paper is made to imitate morocco leather, shagreen, moleskin, &c., and employed for higher priced wares. As in Europe, paper is used in Japan for making cardboard, light boxes, and such-like articles. Amongst other purposes to which it is applied may be mentioned cabinet-work, the manufacture of floors, screens, and roofs, umbrellas, &c., &c.

The following materials are employed in paper-making by the Japanese:—The bark of the paper-mulberry, *Broussonetia papyrifera*, in Japanese, *Kamino-ki;* the bark of *Daphne papyrifera*, a shrub designated by the Japanese, *Mitsoumati*; also, *Passerina gampi*; the bark of the willow yields a strong but common paper.

The *gampi* yields a finer paper than the *Mitsoumati*, and the latter a finer paper than the *Kamino-ki*, which is chiefly used for papers requiring great strength. The manufacturing process is very simple, and is carried on without the aid of machinery of any kind. The bark of one or other of the above-mentioned trees or shrubs is boiled, after having been stripped of its epidermis and reduced to suitable dimensions. It is then ground to pulp by hand; the pulp is drawn on bamboo-screens resembling the wire-frames used by European makers, and when the water has drained off sufficiently, the sheets are laid on planks to dry. Nothing can be more simple; but when Japanese industry has made further progress, and education has penetrated the masses, the demand for paper will probably compel recourse to machine-making and steam-drying, and even to the importation of paper from Europe, a contingency which it is quite possible may be by no means remote, bearing in mind the spirit of imitation and initiative displayed by this singular people, and the vast strides in civilisation made by them in the intervals between successive international exhibitions.

The exhibition of Chinese papers was very inferior to the Japanese. At first, the Chinese government disdained to take notice of the subject; but eventually, through the intervention of some commercial firms established in China, some specimens of Chinese manufacture were secured and sent for exhibition. The exhibits were mostly of secondary importance. But they included a good choice of letter and envelope papers of all sorts, and some coloured papers of very beautiful shades. There were albums, also, of coloured and lithographic designs on a paper resembling ivory, made from the pith of the bamboo. The beautiful China paper once used for choice engravings was conspicuous by its absence, owing probably to the fact that it has been in a great measure, if not altogether, replaced by the imitation China papers manufactured by Blanchet Brothers, Kleber, and Breton of Isère. A merchant resident in China had conceived the happy idea of exhibiting a toy model of the paper-making process as practised in China. From this it was seen that in China as in Japan the mode of procedure is very primitive, and that, as might be expected, there is great similarity between the modes of fabrication and the materials employed in the two countries, which is easily explicable by the close resemblance in climate, race, and habits.

The Chinese papers have not, however, the long tenacious fibres of the Japanese, owing to the Chinese practice of leaving the pulp to macerate in pits, which adds to the silkiness and closeness of grain, but renders the paper very brittle. It was noticeable that all the Chinese papers were largely weighted with kaolin.

Persia exhibited no paper, none being there made. Some ancient Chaldean MSS. figured in a glass case, suggesting that once the art was not unknown in Iran. It is to be hoped, in the interests of civilisation, that amongst the ideas carried home from his European peregrinations by the Shah, the utility of developing this branch of industry may have found a place.

Turkey no longer manufactures paper. Some albumenized paper, suitable for MSS. was exhibited; also a kind of school paper faced with a peculiar composition, which permits of the repeated effacement of the writing, like a slate.

Egypt has made more progress. The Viceroy has established a paper-mill at Cairo at his own expense, and specimens of its manufacture, white, blue and whity-brown, were shown. All were of inferior quality, but many of them strong and well-sized nevertheless. Some had been made from papyriferous plants. What were the prospects of this establishment did not appear. The Egyptian exhibits included some effaceable paper similar to that in the Turkish section.

Greece has no paper-makers, and exhibited no paper. Let us hope that the Hellenic kingdom, which has just given the name of "Didot" to a street in its capital, may feel called upon to fill this lamentable hiatus in a land that aspires to revive all the traditions of a glorious intellectual past.

The nations that make the most and the best paper are France, England, Austria, and Germany. France had formerly a monopoly of paper-making material, but for the last ten years her finest rags have been sold, at a profit, to English and American makers. Neighbouring countries have at the same time been making progress in this branch of industry, once confined to England and France. This progress has received notable assistance from the use of straw, wood, and other succedaneous pulp. Numerous and important manufactures of this specialty now exist in Belgium, Switzerland, Germany, Austria, Sweden and Norway; whilst England appears steadily to monopolize the esparto crops of Spain and Algeria. France has been slower in developing this branch of industry, and so whilst her best rags have been exported for the benefit of foreign makers on the other side of the Channel or across the Atlantic, her neighbours in central Europe have provided themselves with a substitute, which is at once cheap and abundant. In England, the paper trade appears flourishing. Amongst the various causes contributing to its prosperity may be ranked the prodigious elasticity of her export trade.

Belgium has a more restricted production, and was not represented at Vienna.

In Austria this branch of industry is now well found, and is carried on upon an extensive scale. She will no doubt prove a formidable competitor in the Levant trade.

The German paper trade is also well found, and has assumed a very considerable development of late. The German race, essentially migratory, spreads into every corner of the earth, founding commercial establishments, which become every year more numerous, and are naturally designed to push the sales of home produce wherever there is a chance of a demand. Here unquestionably lies a formidable danger for French industry in general, and more particularly for the paper trade, as the French and German papers are alike.

Italy has established paper manufacture in most of her provinces. Russia also has made notable progress in the same branch of industry.

[1] "Revue Industrielle."

WYSS AND STUDER'S HYDRAULIC MOTOR.

IN the annexed plate we give detailed figures of a new hydraulic motor, the invention of MM. Wyss and Studer, engineers, of Zurich, to which reference has already been made in another number ("Practical Magazine," May, 1875).

It will be seen from figs. 1 and 2, which represent the machine in profile and ground-plan, that it consists of an oscillating cylinder, with fly-wheel attached, the movement being produced by water entering the cylinder through both trunnions, from a feed apparatus mounted on the same bed-plate as the machine. By this arrangement great steadiness and solidity are secured. The provision for the intromission and emission of the water is shown with sufficient minuteness in figs. 3, 4, and 5 to render explanatory details unnecessary.

Experiments with one of these machines, having a cylinder of 3·4 in. internal diameter and a stroke of 6·7 in. have been made by M. Burkli-Zeigler, municipal engineer of Zurich, who reports that the draught of water produced by the machine varied from 40 to 45 ft. He estimates the useful effect at 90·2 per cent. Between 60 and 120 revolutions of the crank axle per minute was found to be the most advantageous speed. The absence of noise and vibration were especially noticed.

Equally favourable reports have reached us from France of this machine, which has been patented in Europe and America.

We are requested to state that MM. Wyss and Studer are willing to dispose of their patent rights in this country, and are open to entertain proposals from parties willing to treat for the same.

THE NORTH OF ENGLAND IRON AND ALLIED TRADES.

THE iron trade has no more important adjunct than the blast furnace. By that appliance, and by that alone, the cost and quality of cast iron is governed. It is no exaggeration to say that the improvements that the blast furnace has undergone during the last fifty years have maintained for Great Britain, in the face of a foreign competition keener and more insidious than we have ever before experienced, the proud title of the World's Workshop. But the genius for mechanism[1] which our American cousins accorded to Englishmen many years ago has in nothing been shown more conspicuously than in the graduated stages of progress, whereby the blast furnace has been developed from its originally imperfect and chrysalis condition into its present perfect proportions.

The first blast furnace of which we have any reliable record appears to have been built in France, and it is said that one of the earliest makers of pig iron in England imported a workman from France to teach him the art. The first furnaces built in this country were necessarily small and imperfect; nor do we find that smelting operations were carried on on anything like a large scale until the beginning of the second quarter of the present century. It was found necessary in 1581 to enact stringent laws to prevent the consumption of timber in any new ironworks within twenty-two miles of London; but even so recently as 1825 there were no more than 615,236 tons of iron produced in Great Britain,[2] while, in 1840, the production had increased to 1,395,900 tons. In the interval between these two dates, Mr. J. B. Neilson, of Glasgow, took out his patent for the use of heated air instead of the cold blast, which had alone, until then, been used to support internal combustion in the blast furnace. In three years, by the use of this process, the quantity of coal necessary to smelt a ton of iron was reduced from $8\frac{1}{10}$ tons, coked, to $2\frac{1}{4}$ tons used in a raw state, and the production of iron was at the same time greatly increased, owing chiefly to the use of a larger size of furnace. In 1848 the whole production of the United Kingdom reached 2,008,200 tons, while the total number of furnaces built was 623, and in 1857 the production of pig iron had advanced to 3,659,447 tons, with 823 furnaces available for use. Other improvements and economies, which shall be more or less dealt with hereafter, were meanwhile brought to pass.

The very brief allusion here made to the antecedent progress of the iron trade of this country was in some sort necessary, to enable the reader rightly to understand the marvellous rapidity of its subsequent development.

It is doubtful whether the North of England could have taken up the premier position it now occupies as the greatest of iron-producing districts, had not mechanical skill and engineering boldness been allied with peculiarly favourable natural resources. Ample evidence can be brought to show that for seven or eight years previous to 1850, practical men were aware of the existence of the ironstone of Cleveland; but up to that year the enterprise essential to its development does not appear to have been forthcoming. Even up to 1854 the North of England furnished less than 20 per cent. of the whole make of pig iron in the British Isles, which was estimated in that year to be 3,069,838 tons; and in 1856 the average number of blast furnaces in activity during the twelve months was only 33, while their aggregate production was only 247,500 tons. Of this quantity, 49,807 tons were shipped to foreign ports, 25,800 tons were in stock at the end of the year, and 190,393 tons remained for local consumption. From 1856 to the present time the iron trade of Cleveland has pursued a career of unparalleled prosperity. The following figures, compiled from official documents, show the graduated growth of the staple industry of Cleveland during the last sixteen years:—

	Tons.
In 1859 the pig iron made from Cleveland ore was	620,062
1860 " " " "	633,000
1861 " " " "	607,000
1862 " " " "	705,529
1863 " " " "	838,400
1864 " " " "	926,054
1865 " " " "	957,311
1866 " " " "	1,043,529
1867 " " " "	1,156,953
1868 " " " "	1,233,418
1869 " " " "	1,459,508
1870 " " " "	1,695,377
1871 " " " "	1,884,239
1872 " " " "	1,968,972
1873 " " " "	1,999,491
1874 " " " "	2,001,233

It is instructive to compare with the above figures the following tabulated statement of the progress of the manufacture of pig iron in the United Kingdom for the same period:—

Year.	Tons.	Value.
1859	3,712,904	£9,282,260
1860	3,826,752	9,566,880
1861	3,712,390	9,280,975
1862	3,943,469	9,858,672
1863	4,510,040	11,275,100
1864	4,767,951	11,919,877
1865	4,819,254	12,048,133
1866	4,523,897	11,309,742
1867	4,761,023	11,902,557
1868	4,970,206	12,381,280
1869	5,455,757	13,614,397
1870	5,963,515	14,908,787
1871	6,627,179	16,667,947
1872	6,741,929	18,540,304
1873	6,566,451	18,057,739[1]

Here, then, we find embraced within the briefest possible compass the statistical history of the growth of the greatest industry of modern times. The whole annals of commerce would fail to show anything more remarkable. Under ordinary circumstances, the multiplication of figures is a tedious and unattractive process, but here we find them invested with all the excitement of fiction; and the wildest vagaries that ever were perpetrated in the realms of romance cannot surpass, in their power to stimulate interest and curiosity, the wonder-stirring tendency of these statistics.

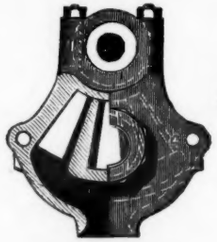
The recent growth of the iron trade has been mainly confined to Cleveland. Wales, Scotland, and Staffordshire have each had their day. In two at least of these older districts the production of pig iron has fallen off rather than advanced of late years; and in all three, the probabilities of future development are rather remote.

Cleveland, to begin with, had an uphill struggle. Many men would have succumbed to the competition and discouragement which confronted the pioneers of the iron trade of that district. Natural resources were not sufficient to conquer these drawbacks. They had to be lived down and vanquished by force of superior energy and skill. These qualities were forthcoming in

[1] Sir S. M. Peto's "Resources and Prospects of America."
[2] Scrivenor on "The Iron Trade."

[1] The official figures for 1874 have not yet been published.

Fig. 3.



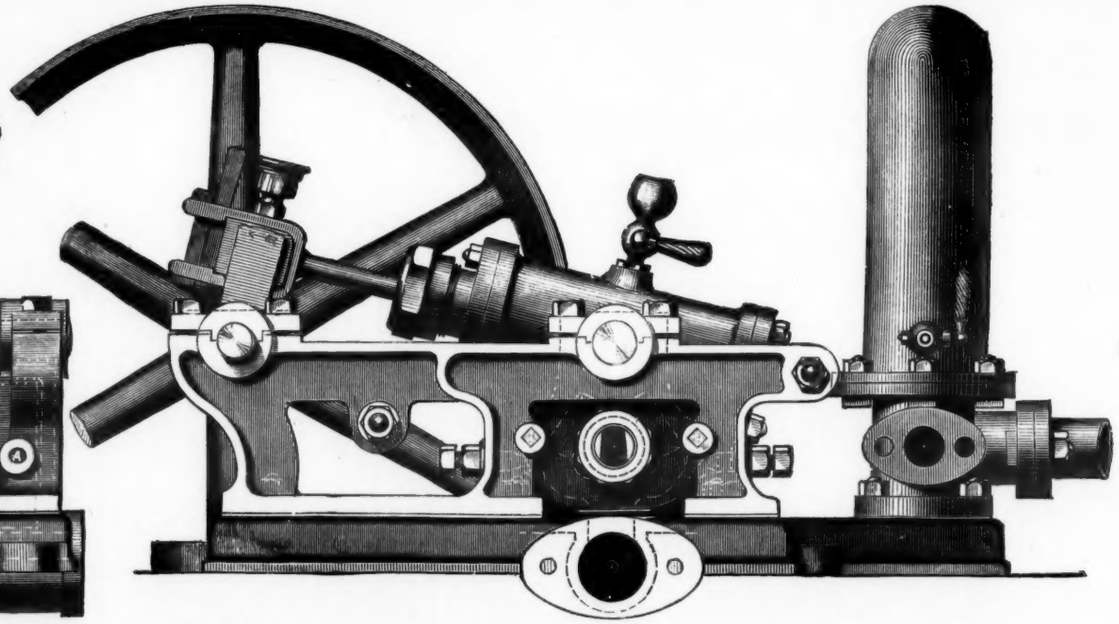
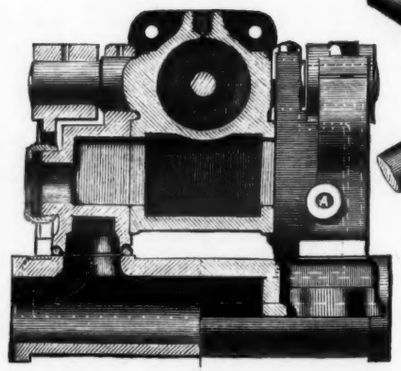


Fig. 1.

Fig. 4.



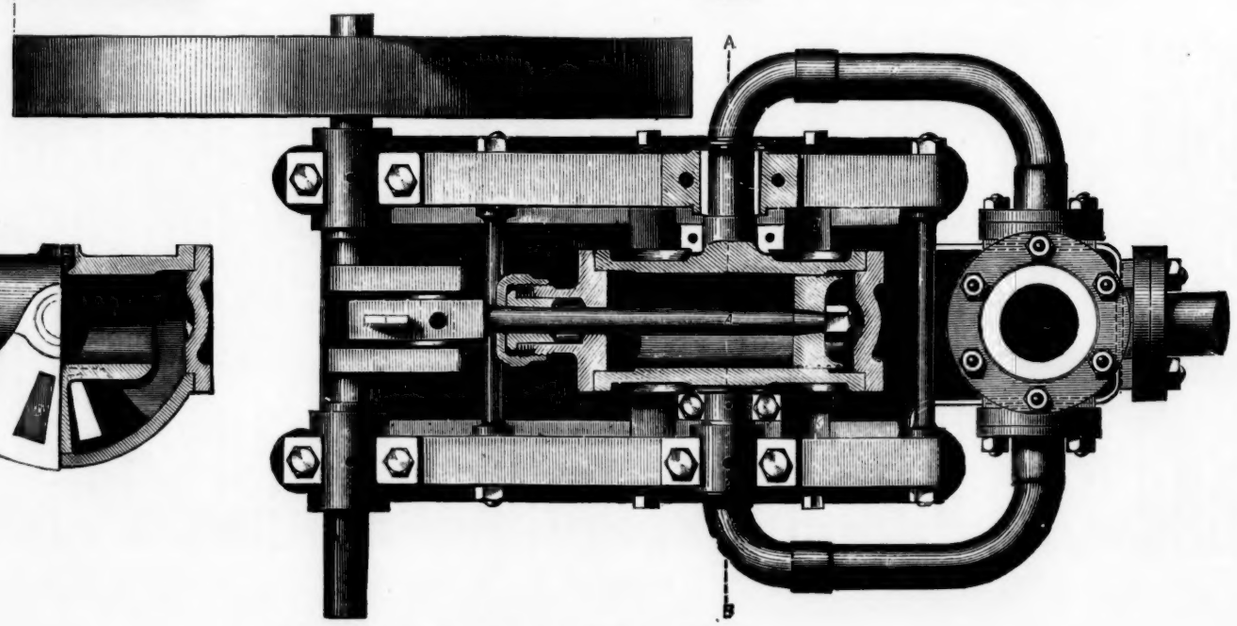


Fig. 5.

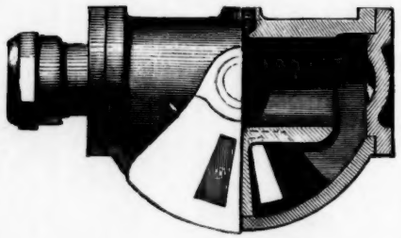


Fig. 2.

WYSS AND STUDER'S HYDRAULIC MOTOR.

a remarkable degree, furnishing another signal proof that when the hour comes it brings the man with it.

Had the engineers of Cleveland been content simply with following the practice of other districts, their advance would have been measured by inches instead of by ells. But every new pioneer seemed to be more of an iconoclast than those who had preceded him. They did not uproot old customs and prejudices for their own sakes, but because they felt that mechanical improvement was not only possible, but necessary, if the iron trade was to prosper.

The first blast furnaces built in Cleveland proper were those erected at Middlesbrough in 1851 by Messrs. Bolckow and Vaughan. Their height was only 42 ft., and their cubical capacity was 4,566 ft. These were followed in the ensuing year by two furnaces built by Messrs. Gilkes, Wilson, Pease, and Co., at the Tees Ironworks, each having a height of 45½ ft., and a cubical capacity of 5,100 cubic ft. The consumption of fuel at these furnaces did not indicate any advantage over the Wylam furnace built some years previously by Messrs. Bell Brothers, although the latter was only half the size of the former.[1] The iron makers of Cleveland were without any reliable data to guide them to a just conclusion regarding the economical effects of increasing the size of the blast furnaces. Instinctively they appeared to divine that something was to be gained by increased cubical capacity, if not by augmented height, and, here a little and there a little, they proceeded to make experiments tending to that object. Antecedent experience rather discouraged than recommended the adoption of a great height. No furnaces built at that time exceeded 50 ft. altitude, while the majority were under 40 ft. On the continent the blast furnaces in use were smaller still. A furnace built at Malapane, Silesia, was only 27 ft. high, with boshes 9 ft. in diameter. The usual height of the blast furnaces used in Germany for the smelting of bog ores by charcoal was only 30 ft., while the concave boshes measured 7 ft. at the widest part. The modern blast furnaces of Sweden usually attained a height of 35 ft., and in Russia some furnaces of a similar height were built on what was then considered a large scale, with a weak blast, adopted for the economy of fuel. At Eisenerz in Styria, there were thirteen furnaces, specially constructed for the smelting of sparry carbonates, with a height varying from 30 to 38 ft., and boshes 8 ft. 9 in. in diameter. A furnace built about 1852 by the Prussian Government on the banks of the Rhine, and designed for the making of foundry metal from brown iron ore, hydrated oxide of iron, was carried to the height of 35 ft., and had a bosh of 9 ft. 8 in. Nor were American furnaces, despite the bigness of that country and its claims, of a much larger size. The charcoal furnaces of Eastern Pennsylvania did not exceed 35 ft. in height, and the furnace at Cold Spring, New York, 40 ft. high and 9 ft. bosh, was regarded as one of large dimensions.[2]

It is probable that the pioneers of the Cleveland iron trade did not go so far a-field in seeking for precedent. The iron manufacturers of Wales, Staffordshire, and Scotland laid claim almost to a monopoly of blast furnace experience, and it seemed a bold if not a hazardous thing to attempt an innovation which was at variance with the custom and experience of these older districts. But the ironmasters of Cleveland were a law unto themselves. They each contributed their quota to the solution of the problem of greater cubical capacity in the furnace, as will be seen from the annexed table, prepared by Mr. John Gjers, of Middlesbrough, to show the increase of size in the blast furnaces of Cleveland, according to the orders of their respective dates.

The Ferryhill Iron Company in 1868 built two furnaces, omitted from the following list, which were carried to the extraordinary altitude of 103 ft., with 27 ft. 6 in. diameter of bosh. These unique furnaces have carried the theory of great height and cubical capacity to its extreme consummation, and they are still without a rival to their claim of being the largest blast furnaces in the world. The experience of the Ferryhill Iron Company is a counterpart of that resulting from the same cause to every pig iron maker in Cleveland. The first blast furnaces built at Ferryhill fifteen years ago were only 48 ft. in height, and they consumed, with a magnetic ironstone containing nearly 50 per cent. of metal, over 30 cwt. of coal to one ton of iron made. When four additional furnaces were built by the same company in 1866, they were carried to a height of 80 ft. with 21 ft. diameter of bosh, and the consumption of coal was reduced in these furnaces to 20 cwt. per ton of iron made. It was this remarkable result that led the Ferryhill Iron Company to resolve upon still larger furnaces, and they found that in their 103-ft. furnaces it was practicable to work with a consumption of only 17½ cwt. to the ton of iron. The out-put of the larger furnaces was at the same time found to be proportionately greater than that of the smaller ones. In the 48-ft. furnaces the weekly production did not exceed 200 to 250 tons; in the 80-ft. furnaces it was increased to 350 tons; but in the 103-ft. furnaces it was no unusual thing to obtain a production of 600 tons per week. Other two new furnaces are now being completed by this company, each of which will have an altitude of 105 ft. from the hearth, and a cubical capacity of 55,000 cubic feet. The diameter of the bosh is 33 ft., and the height of the bosh is 38 ft., while the foundation is 12 ft. deep with 6 ft. of solid concrete and 6 ft. of hearth. It is calculated that each of these furnaces will be equal to the production of 660 tons of pig iron per week.

Date.	Name of Firm.	No. built.	Height.	Diameter of bosh.	Cubic capacity.
			ft. in.	ft. in.	ft.
1851	Bolckow and Vaughan	3	42 0	15 0	4,566
1853	Bell Brothers	6	47 6	16 6	6,174
1853	Bolckow and Vaughan	6	54 0	15 0	7,116
1853	Gilkes, Wilson, Pease, and Co.	2	45 6	14 6	5,100
1854	Cochrane and Co.	4	55 0	16 0	7,175
1854	B. Samuelson and Co.	3	50 0	14 0	5,050
1854	Bolckow and Vaughan	3	54 0	15 0	7,116
1854	Gilkes, Wilson, Pease, and Co.	2	55 0	14 6	6,800
1856	Stockton Furnace Co.	3	50 0	16 0	6,341
1856	Norton Iron Co.	3	50 0	15 0	6,000
1858	Thomas Vaughan	6	56 0	16 0	7,000
1858	Hopkins, Gilkes, and Co.	2	56 6	16 0	7,200
1858	Jones, Dunning, and Co.	2	58 0	17 0	8,000
1858	Bolckow and Vaughan	1	61 0	16 4	7,960
1861	Gilkes, Wilson, Pease, and Co.	1	55 0	16 0	7,700
1861	William Whitwell and Co.	3	60 0	20 0	12,778
1862	Bolckow and Vaughan	2	75 0	16 6	11,985
1864	B. Samuelson and Co.	4	69 0	20 0	15,500
1864	Lloyd and Co.	4	67 0	20 0	15,000
1864	Thomas Vaughan	6	81 0	19 0	16,000
1864	Stevenson, Jacques, and Co.	3	70 0	22 0	17,000
1865	Gilkes, Wilson, Pease, and Co.	2	75 0	21 0	17,700
1865	Bell Brothers	2	80 0	20 6	15,500
1865	Bolckow and Vaughan	2	95 6	16 0	15,050
1866	Ditto	1	75 0	20 0	12,972
1866	Hopkins, Gilkes, and Co.	2	75 0	24 0	20,000
1866	Swan, Coates, and Co.	2	75 0	20 0	16,090
1866	Bell Brothers	2	80 0	17 0	11,500
1867	Norton Iron Company	2	85 0	25 0	26,000
1867	Cochrane and Co.	2	76 0	23 0	20,624
1868	Gilkes, Wilson, Pease, and Co.	1	75 0	24 0	22,500
1868	Stevenson, Jaques, and Co.	1	70 0	23 0	18,000
1868	B. Samuelson and Co.	1	69 0	21 6	16,000
1868	Lloyd and Co.	2	80 0	21 6	18,000
1868	Jones, Dunning, and Co.	3	73 0	18 0	12,000
1868	Bolckow, Vaughan, and Co.	2	95 6	22 0	25,940
	Ditto	1	95 6	23 0	28,800
1869	Thomas Vaughan	3	85 0	25 0	26,000
1870	Bell Brothers	4	80 0	25 0	25,000
1870	Stockton Furnace Company	2	80 0	24 0	24,613
1870	Swan, Coates, and Co.	1	75 0	23 8	22,229
1870	Cochrane and Co.	2	90 0	30 0	41,149
1870	Gilkes, Wilsons, Pease, and Co.	2	85 0	27 0	32,000
1870	B. Samuelson and Co.	2	85 0	28 0	30,000
1871	Bolckow, Vaughan, and Co.	2	95 6	24 0	28,950
1871	Lackenby Iron Company	2	85 6	25 6	26,670
1871	Gjers, Mills, and Co.	2	85 0	25 0	26,000

Between a cubical capacity of 4,666 ft. and one of 55,000 ft. a height of 42 ft. and one of 105 ft., a bosh of 15 ft. and one of 33 ft. there is an almost antipodean distance; but herein the blast furnace practice of Cleveland, in its progress and vicissitudes, fitly symbolizes the rapid and extensive growth of the great industry on whose behalf it is employed.

Among practical men there is a considerable disparity of opinion as to the limit of height and cubical capacity that may be employed most advantageously in blast furnace practice. The chief merit claimed for the higher furnaces of Cleveland is a saving of coke; but it is also found that in blast furnaces of a certain altitude, up to at least 80 ft., the iron is more highly carbonized than in the smaller furnaces. The first public attempt to examine the subject scientifically appears to have been made by Mr. Charles Cochrane of Middlesbrough and Dudley, who, in a paper read before the Society of Mechanical Engineers,[1] pointed out that the actual quantity of coke necessary in a blast furnace was that demanded for the reduction and carburizing of the iron, and this he estimated at 7·43 cwts. per ton of metal. Mr. Cochrane, in the discussion which followed the reading of his paper, expressed a hope that by still further increasing the dimensions of the furnace, enough heat might be conveyed into it to enable a ton of Cleveland iron to be produced with 13 cwt. of coke.

Many men of large experience and sound judgment have disagreed with Mr. Cochrane's conclusion. It has been argued that by indefinitely adding to the dimensions of a blast furnace, the danger of scaffolding is increased. A great deal, however, depends upon the arrangement of the angles of a furnace. If it is too straight, scaffolding will probably be in an inverse ratio to

[1] Preface to "Chemical Phenomena of Iron Smelting," by J. L. Bell.
[2] Overman, "On the Manufacture of Iron."

[1] "Proceedings," January, 1869.

height and capacity; but if there is a sufficient angle to allow of the proper fall of the materials inside, there is little danger of hanging.[1] Hence the new furnaces at Ferryhill are built with two angles, one outwards and the other inwards; and had the same measurements been adopted in the large furnace of 90 ft. high and 41,000 ft. cubical capacity, built in 1870 at the Ormesby Works, the failure which is known to have attended its operation would probably not have occurred.

In his evidence before the Commissioners appointed to inquire into the several matters relating to coal in the United Kingdom on the 25th February, 1869, Mr. J. L. Bell[2] stated that in furnaces of 10,000 to 15,000 ft. of cubical capacity it was possible to obtain all the economy in fuel, of which a mere increase of size is susceptible; that furnaces over 100 ft. in height do not work much better than a furnace 80 ft. high; that the larger furnace would require an additional pressure of blast, and was a failure to the extent of having been raised to an unnecessary height; and that the quantity of carbon or coke necessary to make a ton of iron with the usual run of Cleveland ore was not less than 17 to 18 cwt. The same high authority stated at the same time that the present consumption of coke with the best furnaces was about 23 cwt. of coke to the ton of iron. With these views the experience of the majority of iron makers is identical. Few furnaces are now working in Cleveland with a less consumption than 22 cwt. of coke per ton of iron. This, however, represents a difference of at least 10 cwt. of coke per ton of iron made, as compared with the average consumption of fifteen years ago; and on the present out-put of over 2,000,000 tons of pig iron per annum the aggregate annual saving is not less than a million tons of coke.

The adoption of increased height and cubical capacity in the blast furnaces of Cleveland has been attended with such obvious and important advantages that efforts have been made to introduce the same improvements into nearly all the other iron producing districts of Great Britain. It so happens, however, that no other district possesses conditions so highly favourable to such a change. The hardness of the South Durham coke, which is the fuel mainly used in the smelting of Cleveland ironstone, enables it to support a great burden in the furnace, without the usually attendant danger of crushing or scaffolding. Every attempt to increase the height and capacity of the blast furnaces of Scotland was more or less attended with failure, until Mr. William Ferrie, of the Monkland Iron Company, erected at the works of that name a furnace, formed by building four chambers or retorts, on the top of one of the old furnaces, about 20 ft. in depth, and each having a capacity of 500 cubic feet, the body of the furnace itself containing 7,000 cubic feet.[3] These retorts are heated by a portion of the escaping gases being burned in external flues, and the result is a saving of about 19 cwt. of coal to the ton of iron. "This," says Mr. Bell,[4] "was demonstrated under circumstances so convincing that we may accept it as a fact beyond all dispute that, while 52·5 cwts. of raw coal were required to make a ton of iron in a furnace of 53 ft. in height, 33·5 cwt. sufficed in what Mr. Ferrie calls his self-coking furnace, with a height of 83 ft." It is claimed for Mr. Ferrie's furnace that its general use throughout Scotland would represent upon the total annual make of pig iron a saving of something like 1,092,500 tons of coal per annum, in addition to 115,000 tons in iron ores, and 460,000 tons in dross.[5] The Ferrie furnace has been introduced at several of the largest works in Scotland, and has been found to suit the peculiar requirements of iron smelting in that country much better than a furnace of the ordinary kind. Most of the Welsh furnaces are for anthracite coal, which prevents them from carrying a heavy burden or being carried to a great height. Mr. J. L. Bell does not believe that there is a single blast furnace in Wales, using anthracite, making more than 6,000 tons of pig iron per annum, whereas in Cleveland each furnace makes 16,000 tons of pig iron or upwards per annum. This difference is due to the fact that the Durham coke preserves its size almost from the top to the bottom; but the anthracite coal decrepitates or falls into small pieces on the application of heat, and hence it cannot be applied to furnaces of great size.[6]

In the midland counties there has, within the last few years, been a movement in the direction of larger furnaces. It has been found, by adding 15 ft. to the height of the Old Park Company's furnaces, (1) that an improved yield has been obtained from increase of height; and (2) that to the extent of 60 ft., it may be safe to construct furnaces in districts having tender cokes to smelt with. In 1869-70 the blast furnaces of the Clay Cross Iron Company in Derbyshire were raised from 48 to 60 ft., while the diameter of the boshes was increased 1 ft.; and in 1868, the old Wingerworth Ironworks in the same county were remodelled, and the height and capacity of the furnaces increased with advantageous results. The average height of the furnaces in the new iron-making district around Frodingham, in Lincolnshire, is from 65 to 70 ft., but it has been found that it is adverse rather than advantageous to exceed the latter height. In the hematite regions of Cumberland and Lancashire there are no furnaces built to a greater height than 70 ft. The average height of the furnaces of the Barrow Hematite Iron and Steel Company, which are the largest works on the west coast, and serve as a model for all the others, is less than 60 ft., and even at the present day there are few furnaces in Staffordshire built to a greater height than 50 to 55 ft., while many of them are not over 45 ft.

The economies resulting from the utilization of the waste gases of the blast furnace, and from the application of a higher temperature of blast, have scarcely been less important than that which has accrued from increased size and height. The former improvement is said to have originated in France, where M. Aubulot, in 1811, took out a patent for the employment and utilization of waste gases, reserving to himself their application in the cementation of steel. It was not, however, until 1845, when Mr. Rudd took out a patent for the same thing in England, that this improvement became generally familiar, or to any extent adopted. Mr. Rudd not only applied the waste gases to the heating of the blast at his own furnaces, but also to the generation of steam in the boilers. Those, however, who are at all conversant with the history of the iron trade must be fully aware that it was not until within the last fifteen years that any system of utilizing the waste gases of the blast furnace came to be generally adopted, or even regarded with anything like favour; and it was in Cleveland that the close-topped furnace of the present day may be said to have reached the maturity of its development. In most other districts, indeed, it was considered that the closing of the furnace top exercised an adverse effect on the quality of the iron, and for this reason—whether well-founded or otherwise we will not pretend to say—many of the furnaces in operation in Scotland, Wales, and the west coast of England are still open-topped, and send forth into the air volumes of unconsumed carbon, that represent a direct loss of at least 5 to 10 cwt. of coal to the ton of iron made. In the Cleveland district the gases are taken away from the furnaces by what is technically called the bell-and-hopper, or cup-and-cone apparatus, and conveyed in pipes varying in diameter from 2 ft. and upwards to the stoves and boilers. There are two or three furnaces in Cleveland exclusively used for the manufacture of hematite iron, where the provision for the utilization of the waste gases is not in force; but, with these exceptions, the system is universal, and is found to save all the fuel that would otherwise be necessary to raise the steam in the boilers and the blast in the stoves, or within the most infinitesimal fraction of that quantity. In some of the Scotch furnaces—as, for example, at the Glengarnock Works of Merry and Cuninghame—the same provision is made for economizing the waste gases, and every year brings it more into repute, so that the traveller from Carlisle to Glasgow viâ Coatbridge will perhaps live to see the day when he will not be startled in his midnight dreams or cogitations by the fierce glare of the numerous blast furnaces on that route.

More than any other district at home or abroad, Cleveland has been associated with the improvement of stoves for heating the blast, and the adoption of a high temperature in the process of smelting. One of the earliest plans for the heating of air of which we have any record was that of Robert Stirling, clerk, of Kilmarnock, in 1817. It was proposed to be applied to the heating of airs, gases, and other fluids, but it was not applied to the work of the blast furnace. Neilson, the inventor of the hot blast as applied to the smelting of iron, first erected a wrought-iron box, heated by a fire grate, and having heated the air by passing it through the box, he found that with an increased temperature of even 50°, there was a great improvement in the working of the furnace. It was not until 1832 that Neilson was able to secure an apparatus fully suited to his purpose; but this he attained in the semi-circular oven, with round pipes, yielding a temperature of 600°, which is admitted to have been the parent of all subsequent apparatus.

In 1834 Messrs. Lloyds, Fosters, and Company, of Wednesbury, adopted a plan for heating the blast within a cellular tunnel-head of wrought iron. The cold blast was delivered to it from several apertures, so placed as to distribute the air against the side exposed to the action of the flame, and the hot air was conveyed down to the tuyeres in a pipe. The heat obtained was no more than 300°, but a supplementary heating stove was erected by the tuyere, the more effectually to heat the blast, and

[1] "Engineer," July 31, 1874.
[2] Evidence "On Waste in Combustion," vol. ii. p. 227.
[3] "Journal of Iron and Steel Institute, May," 1871.
[4] "Chemical Phenomena of Iron Smelting," p. 309.
[5] "Transactions of Royal Scottish Society of Arts for 1872."
[6] "Report of Select Committee on Coal," 9th June, 1873.

this is said to have been the first application of the waste heat of the furnace for this purpose.[1]

Between 1834 and 1865 many different forms of heating stoves were introduced to the notice of the trade, including Messrs. Firmstone's stove, brought out at the Lays Works, Dudley; the Dowlais continuous pipe oven, brought out in South Wales in 1836; the Ystalyfera stove, heated by gases drawn from near the top of the furnace; the spiral pipe stove, erected at the Ebbw Vale Works in South Wales; the Codnor Park (Derbyshire) stove of 1836; and the well-known U pipe stove, which was brought out in Staffordshire in 1837.

Mr. Martin Baldwin invented in 1851 the circular oven, containing twenty-four vertical double pipes, 11 ft. high, the blast traversing six pipes at once, and passing up and down four times. In 1858 this stove was considered by the Institution of Mechanical Engineers to be the most perfect up to that date.

Up to this period improvements in blast furnace heating stoves had mainly originated in Staffordshire, Scotland, or Wales; but henceforth all or nearly all the successful attempts at improving this valuable branch of blast furnace practice were to be cradled in Cleveland.

In 1858 Mr. Jones, of Middlesbrough, erected at the Normanby Works a heating stove, which consisted of circular pipes 10 in. diameter, within which were placed 8-in. pipes, and the heat, being applied to the outside of the larger, returned to the chimney down the inside of the smaller pipe. Morton's patent stove was erected at the Thornaby Ironworks, Stockton, in 1862, and was found to be more successful in its principle than any stove erected up to that date, but mechanical defects led to its being abandoned. Mr. Gjers, of the Ayresome Works, Middlesbrough, brought out a new form of stove in 1868, which had two rows of pipes, and admitted at the hot end the gas, which found an outlet at the top, near the cold end. About this time also the stoves of Mr. Player were erected at the works of the Norton Iron Company, near Stockton, and Mr. Benjamin Ford, of Stockton, erected at the works of Bolckow, Vaughan, and Co. a stove which was in principle much the same as Morton's, though its application was more successfully carried out.

The object aimed at in all these and many other efforts to improve the system of heating the blast was to attain the highest possible temperature in the furnace, compatibly with the endurance of the stoves, and thus secure the more complete carbonization of the materials, and greater economy of fuel. The pipe stoves, however, were continually requiring renewal, even with a temperature of 500° to 600°, and as each pipe costs on an average £10 to £13, a large margin had to be allowed for depreciation, to say nothing of the loss of time and irregularity in the working of the furnace, caused by the stoppage of the stoves.

It was under these circumstances that practical men commenced to direct their attention to the use of fire-brick. In 1856 Mr. F. Siemens took out a patent for improvements in furnaces, with this purpose in view, but the plan with which his name is associated was never adopted in Cleveland to any considerable extent. The stove which was patented in 1857 by Mr. Alfred Cowper was adopted by Cochrane and Co. at the Ormesby Works, near Middlesbrough, and yielded such satisfactory results that they commanded a large amount of attention from the trade. The principle of the Cowper stove was unlike any of those that had preceded it. The air under pressure was heated by being passed through regenerators, which consist of air-tight cases of iron lined with fire-brick or other non-conducting material, a number of tortuous passages being made for the air, while another set of passages in close contact with them serve for the products of combustion. Mr. Cowper's stoves have been erected at Barrow-in-Furness, Ebbw Vale, Pontypool, and other large works. The inventor has prepared the following statement,[2] showing the comparative economy in blast of ordinary and high temperatures:—

The first cost of the improved regenerative stoves for from 8,000 to 9,000 cubic feet of air per minute, at 1,400° to 1,500°, including royalty	£3,367
The common cast-iron pipe stoves for from 8,000 to 9,000 cubic feet of air per minute, at 1,000°	£4,000
The annual cost of the common cast-iron pipe stoves for from 8,000 to 9,000 cubic feet of air per minute:—	
Interest at 5 per cent. on £4,000	£200
Cleansing one stove same as regenerative stoves	—
Renewal of stoves once in ten years	400
	£600
The annual cost of the improved regenerative stoves for from 8,000 to 9,000 cubic feet of air per minute:—	
Interest at 5 per cent. on £3,367	£168
Cleansing the stoves same as pipe stoves	—
Repairs	20
By the use of the improved regenerative stoves, a saving would be effected per ton of iron made, of 4 cwt. of coke at, say, 11*s.* 6*d.* per ton × 475 tons per week × 52 weeks	£2,840
The increased make of iron would amount to 50 tons per week × 52 weeks × say 7*s.* per ton profit	910
Less cost of working stoves 600 — 188	412
Increased profit per annum	£4,162

Mr. Charles Cochrane has found that the Cowper stove with a temperature of 1,000° yields an economy of 4 cwt. of coke to the ton of iron made, as compared with any other stoves previously in use.

These results, however, have been quite equalled, if not surpassed, by the well-known Whitwell fire-brick stove, which is now more extensively used in the Cleveland district than any of its many rivals. Mr. Whitwell's stove is capable of maintaining a steady temperature of 1,300° to 1,400°, and from the simplicity of its construction, the difficulty and heavy cost of cleaning is overcome. At the works of the Consett Iron Company, these stoves, with a temperature of 1,400°, reduced the consumption of coke to 17 cwt. 3 qrs. per ton of iron produced, the quality of the iron being 84 per cent., No. 4 grey forge.[1] The patentee has succeeded in getting his patent introduced into every iron producing district in the United Kingdom, while on the Continent and in America they are as well known to blast furnace engineers as any appliance in the trade. There are still those who prefer Cowper's stove to Whitwell's, but both alike are entitled to claim that they have done as much as any invention of recent date to cheapen and improve the manufacture of pig iron.

Further comments on collateral improvements and their results must be reserved for another occasion.

[1] Whitwell, "Hot Blast Stoves."
[2] "Transactions of Civil Engineers for 1870."

TELLIER'S HYDROMETRIC WATER PURIFIER WITH MULTITUBULAR FILTER.[2]

THIS apparatus, the invention of M. Chas. Tellier, of Brussels, is designed to effect the preliminary purification of water intended for industrial uses by a combination of chemical and mechanical means.

The annexed plate, fig. 1, shows the hydrometric water-purifier in perspective elevation; fig. 2 is a vertical section of the same on the line A B, fig. 3; and fig. 3 is a horizontal section passing through the point C D, fig. 2.

The apparatus consists of two cylindrical covered vessels of plate-iron mounted side by side on a cast-iron bed-plate. In the smaller of these, G, a solution is first made of certain chemical reagents, such as lime-water, where the water contains carbonate of lime, carbonate of soda, where the lime is present in the form of sulphate, &c., the reagents being used singly or collectively, and the proportion of each determined by previous analysis. The larger vessel, I, serves as a filter, and can be used separately for that purpose if preferred.

A brief description of the details of figs. 1 and 2 will enable the principle and mode of working of the apparatus to be understood. H is the feed, the water being turned on or off by a cut-off valve worked by the handle K. A short pipe in the form of a truncated cone connects H with the pipe U V, leading into the larger vessel I. The aperture of S can be closed to any desired degree, at L, by a screw-plug worked by the handle M. The pipe N connects the feed with the interior of G. At O is a branch-pipe with a cast-iron spring-lid, through which the lime-water or

[1] "Journal of Iron and Steel Institute for 1871."
[2] "Revue Indust." 30 June 1875; "Moniteur Indust. Belge," 20 June, 1875.

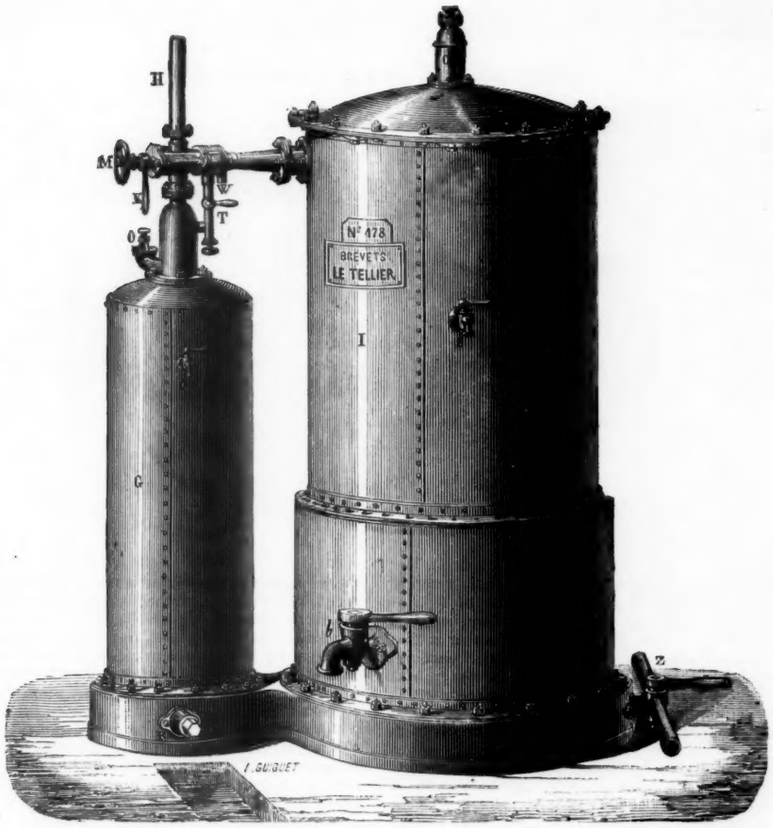


Fig. 1.

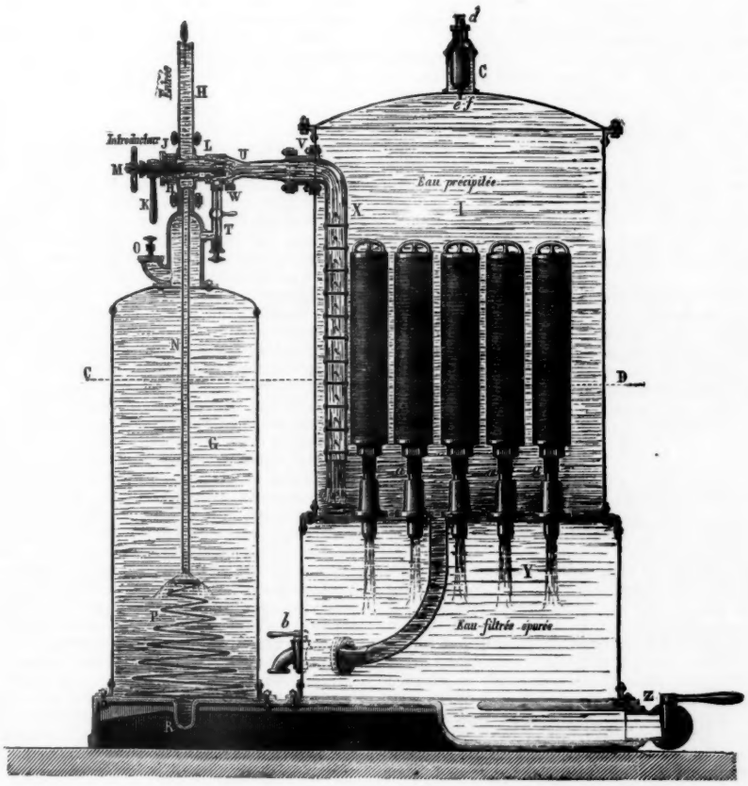


Fig. 2.

TELLIER'S HYDROMETRIC WATER PURIFIER, WITH MULTITUBULAR FILTER.

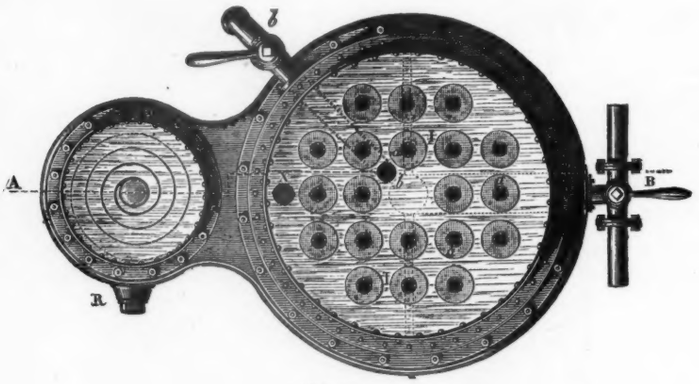


Fig. 3.

other reagent is introduced beforehand in any desired quantity. The water entering under pressure at H—a pressure of 10 ft. is required for the proper working of the apparatus—impinges on a flat disc fitted with a spiral spring P, to which a tremor is thus imparted which communicates itself to the fluid particles around, and ensures the intimate admixture of the water with the solvents introduced through O. A bent pipe connects G with S, and can be closed at will by the handle T. A stop-cock R allows any sediment that may form in G to be run off from time to time.

Now, supposing the water to be turned on, and the vessel G full, on the withdrawal of the screw-plug M, the water from H will be injected, with a force dependent on the pressure, through S into U, setting up therein an exhaust action, which will carry forward with it a certain quantity of atmospheric air, entering through the valves at V and W, and also a portion of the contents of G, which being under pressure will rise through T. The mixture of air and water, reaching V, will descend through X, which is furnished with numerous perforated diaphragms, and gradually fill the upper portion, I, of the larger vessel. The vessel I is provided with numerous filters in the shape of vertical cylinders of perforated felt, *a*, *a*, *a*, compressed between iron plates. It has besides an air valve, worked by a float in the roof. In I, the water in the above state of admixture undergoes a very gradual process of aeration, precipitation and filtration combined, finally sinking through *a*, *a*, *a*, into the separate compartment beneath Y, whence it is run off by the three-way cock Z (B in fig. 3), to the reservoir or other recipient. An escape-pipe, provided with a stop-cock *b*, figs. 2 and 3, permits the sediment which forms in I to be run off as required. Small test-cocks are also provided in G and I, shown in fig. 1, by which the condition of the contents may be examined, and the satisfactory working of the apparatus ascertained.

The hydrometric water-purifier is made in various sizes, the power of each being proportionate to the heat and amount of tubing. No. 0 will deliver 1,000 litres (220 gallons) of pure water per hour; No. 6 delivers 25,000 litres (5,400 gallons) in the same time. The action of the apparatus is continuous so long as it is not connected directly with the pump of the steam-generator.

NITRO-GLYCERINE EXPLOSIONS.

By Chas. L. Kalmbach, M.E.

HAVING manufactured, solely for my own use, nitro-glycerine, fulminate, gun-cotton, and the dynamites, for nearly nine years, and having expended these materials under a great variety of circumstances, on land, in mines, and under water, I have been enabled to accumulate a great number of facts concerning their character. This experience has forced me to dissent from many important and universally received maxims, governing the storage, transportation, and use of nitro-glycerine, and the compounds made of the same. The fact that during all that time I have never met with the slightest so-called accident, confirms my faith in the deductions I have made from these observations. Incidentally, while engaged in these labours, I discovered some improvements in the economical application, as well as in the compounding, of nitro-glycerine with absorbent materials, which improvements are covered by letters patent. Since, however, the specifications cannot relate my experience nor give the reasons for the system of rules I employ, I am induced to publish these notes, to the end that the attention of others may be drawn to a system which has proved so eminently successful in my hands.

On the 14th of April, 1866, an explosion of nitro-glycerine occurred in Wells, Fargo and Co.'s office, San Francisco, resulting in great loss to life and property. A suit for damages arose, which is on record in vol. 15, p. 524, of "Wallace's Reports, United States Supreme Court." From the testimony of the experts examined I quote: "Explosion of nitro-glycerine is produced by percussion and concussion, by a high degree of pressure, but not by contact with fire. If flame be applied it will burn slowly, without exploding, and when the flame is withdrawn it will cease to burn. It will also explode when subjected to a heat of 360° of Fahrenheit."

I believe that the causes of explosion enumerated in the above quotation are to this day universally received as axioms, and that the fact of their unquestioned reception is the fruitful source of many accidents. I assert that but one of them is true and worth guarding against, namely: Nitro-glycerine will explode when heated to about 660° Fahrenheit. I will also state that all compounds containing nitro-glycerine will explode when heated to that degree. Simple concussion or percussion will not explode nitro-glycerine nor the dynamites.

A bottle or other frangible vessel partially filled with nitro-glycerine may be thrown with great violence, or from a height, on rock and shattered without producing explosion. Surely here we have concussion or percussion. But what happens if a tin can or other strong flexible vessel filled with nitro-glycerine is subjected to such an ordeal? Such can will invariably explode when it strikes. The reason is evidently this: Arrested motion converted into heat. The glass bottle breaks by first contact, releasing the contents and allowing them to scatter, thus measurably continuing the motion; the flexible vessel, however, if strong enough, does not release them, but dents or flattens in the direction of the line of motion, thus reducing its cubical internal measure, and producing on the contents rapid or rather percussive compression. This compression evolves an amount of heat exactly depending on the weight of the canister and the rapidity of its motion. For this reason it is difficult to explode the dynamites by similar force and under identical conditions. Being porous and capable of yielding to compression to a degree, they are incapable of evolving the necessary amount of heat for such explosion. It is possible, of course, to compact them sufficiently to neutralize that elasticity and evolve the heat necessary—in fact, they are so compacted every time they are exploded in a mine, but it is evident that the conditions necessary are difficult to attain in the ordinary circumstances attending their storage, handling, and shipment.

Flame may be applied to nitro-glycerine, and it may thus be burned on its surface without explosion, provided that the burning be interrupted before the unburned mass attains the explosive 360° of heat. The dynamites may be burned safely, because, being porous, they are poor conductors of heat, and do not absorb it as readily from the burning surface as the pure nitro-glycerine does. But it would be unsafe to burn a considerable

amount of them in a thick metallic vessel, as the metal would carry the heat from the upper burning portion to the bottom, and thus cause explosion.

The report next mentions "high pressure" as a factor of explosion. It is true that every explosion is attended, or rather preceded, by a high pressure, but it is a pressure developed instantaneously and the most efficient generator of the heat required. Pressure applied so slowly as to allow the dissipation of the heat generated cannot produce explosion. For this reason I doubt whether nitro-glycerine can be exploded in a vacuum.

The report then stated that "It does not explode by the application of fire," which is true enough, if the fire be applied to the open surface of nitro-glycerine of normal temperature, but that is certainly the only way in which fire may be applied to it without producing an explosion. A glowing coal, a hot iron, or a gas jet, applied to the bottom, or even the side, of a tin can, will explode it, for it will heat the film in immediate contact to the explosive point, producing an initial explosion. I say "initial," because if the vessel is entirely open and the point of contact small, the gases produced by the explosion of the film will merely throw the other fluid, nitro-glycerine, aside, and escape with a crackling noise. If the can be full, or closed, or if the mass be frozen, or of great height above the point of contact, the whole will explode, because it cannot get out of the way of the pressure of the first or initial explosion, and this "initial" produces the required compression for the necessary instantaneous evolution of heat. On the other hand, a pan holding a moderate depth of nitro-glycerine may be set over a slow fire and entirely evaporated without an explosion, because the fire evaporation keeps the temperature below the explosive degree. Dynamite is subject to the same law, and differs only to the extent of its porosity.

Nitro-glycerine, if ever so carefully prepared and washed, will slowly decompose, yielding fumes of nitrous acid. If strictly confined these fumes accumulate and exert pressure, which pressure makes it peculiarly sensitive to percussion. This fact has been (doubtless) the sole cause of many, apparently mysterious, accidents.

I find, then, but a single primary cause for the explosion of nitro-glycerine, viz. Heat of not less than 360° Fahrenheit.

I also find that the most direct and efficient way to produce such a degree of heat is by percussive compression.

Knowing the primary cause of its explosion, it should be comparatively easy to make, store, transport, and use, nitro-glycerine in such a manner as to avoid all conditions favouring that cause.

It being important to give free access of or rather to the air, it should be stored in shallow, open, non-metallic vessels, which should not be filled to a greater depth than their diameter.

Stone, or earthenware, glazed inside, is the best material for such vessels, because it is not affected by acids, is not a good conductor of heat, and it is strong, stiff, and brittle. Such vessels are cheap and easily obtained everywhere, lasting an indefinite time. The flexible metallic can is supremely dangerous and unfit for converse reasons.

The shallow, open vessel gives another material advantage in the fact that the contents are always fully visible, and any change in appearance indicating dangerous decomposition may be at once observed and provided for, for it always does change in appearance long before a dangerous stage is reached.

When during, or rather immediately after manufacture, the acids containing the nitro-glycerine are washed in an abundance of well agitated water of a low temperature, the precipitated heavy oil has a white curdy appearance not unlike buttermilk. It is then in its very safest condition, as it is impossible to explode it by any ordinary degree of compression. It is, however, just as strong as it ever is under other more sensitive conditions. I have sent a rifle ball through a tin canister of it without producing explosion, and have fired a strong fulminate primer in another with the same result, viz. tearing the vessel and spilling the contents. When the latter experiment, however, was repeated with a strong champagne bottle the explosion occurred, because the sides of the bottle were strong enough to enable the primer to exert the requisite compression. Such nitro-glycerine, in a temperature of 70° F., will retain this appearance and this quality for one and even two months.

Since it adds so much to the safety it is worth the trouble to store a supply sufficient only for that length of time.

Such nitro-glycerine is peculiarly fitted for shipment, and is safest to carry in boxed stone jugs, which are not to be filled quite full, say three gallons in a five gallon jug. Only a very gradual raising of the temperature will explode such jugs—no amount of crushing force being able to cause explosion, provided the nitro-glycerine remain fluid. As soon as it freezes it separates from the water and will remain so after thawing. Thus it can be made highly sensitive by repeated freezing and thawing. Frozen nitro-glycerine is dangerous to handle and transport, because it is rigidly confined in its crystals, which occupy a less space than the fluid they are formed of. The fracture of a dry crystal will often cause explosion. There is, however, one advantage in keeping nitro-glycerine frozen in store, and it is this: When frozen, the acidulous decomposition noticed in the foregoing column cannot possibly take place, but the nitro-glycerine remains perfectly unaltered as long as it remains hard. Since such decomposition is so slow as to be almost imperceptible, and since it is so easily checked and provided for by simple washing and a superposed film of water, I have always avoided freezing because of the risk involved.

I have, in the above, tried to give a full and intelligible exposition of the true cause of the explosion of nitro-glycerine and the means I have successfully applied to avoid unintentional explosion. I only hope that I have avoided all obscurity of expression, as that is the only chance for misapprehension.—*Van Nostrand's Engineering Magazine.*

PRACTICAL PAPERS ON DESIGNING MACHINERY.

VI.[1]

IN our last paper we considered the various forms of boilers, or, as they ought to be called, steam generators, and the usual rules observed in determining their sizes, and we now come to handle the question of the application of these rules to computing the size of our boiler in order that it may contain the heating and grate surface estimated in our last. And here we must take occasion to explain a point we did not make clear in our last paper. In Paper No. 1 ("Practical Magazine," No. 20) we assumed a boiler pressure of 50 lbs. per square inch, and a cylinder pressure of 40 lbs. In our last paper we calculated the boiler heating and grate surfaces, stating that the cylinder pressure was to be 60 lbs. This, however, does not agree with the pressure we determined on in our Paper No. 1: with this exception the calculations in our last paper are literally correct in themselves, and furnish a good example of practical calculation; but at the same time it is requisite that we should adhere to our resolve to make all our steps a regular chain of links harmonizing mutually, and so we must put the calculation at the 40 lbs. per square inch in the cylinder stated at the outset. We therefore state the calculation thus: we require 71,310 cubic inches of steam per minute, or 41 cubic feet, which equals 41 × 60 or 2460 per hour, as shown in our last paper, and which we now take at 40 lbs. pressure. We have demonstrated in our last paper the laws regulating the relative bulk of steam at different pressures as compared with water; therefore, applying these laws to our present calculations, we find, if speaking very approximately to exactitude, that in a cubic foot of steam there is a cubic inch of water for each 15 lbs. pressure it is raised to. Well, 40 contains $2\frac{2}{3}$ fifteens, hence in each cubic foot of 40 lbs. steam pressure above the atmosphere there is $2\frac{2}{3}$ cubic inches of water, and as we want for our engine 2460 cubic feet of steam per hour we must evaporate 2460 × $2\frac{2}{3}$, or 6560 cubic inches of water, which, reduced to feet, means 3·8, and this brought to terms of pounds (see our last paper) makes 237·5 as the weight of water we must evaporate when using 40 lbs. steam; even as in our last paper, and taking the pressure at 60, we had to evaporate 356 lbs.; taking the same line as before of 8 lbs. evaporated per pound of coal burnt, we have to consume 29·7, or say 30 lbs., per hour, and taking a consumption of 8 lbs. per foot of grate we have to find about $3\frac{3}{4}$ square feet of grate. In our last paper we stated that a customary rule was to allow in cases like this five-eighths of a square foot of grate per nominal horse-power, and as we placed the nominal horse-power of our engine at 6 we can see at once how far our calculation and this rule agree by multiplying 6 × $\frac{5}{8}$ and it comes to exactly $3\frac{3}{4}$. As we observed in our last, however, there is another system of making these calculations which depends on the difference between the term "nominal" as contrasted with "actual" horse-power. The former is an entirely fallacious and misleading expression, which should long since have been removed from the vocabulary of the engineer. We have taken it as equalling the diameter of our cylinder in inches, but we must proceed to ascertain the real power, or as it is commonly called the "indicated" power of the engine. The rule by which to find the indicated horse-power of a steam-engine is as follows:—Multiply the area of the piston in square inches by the pressure of the steam acting upon it in pounds per square inch, and multiply the product of this by the speed of the piston in feet

[1] Continued from p. 94, No. 3, March, 1875.

per minute, and divide by 33,000. Stated as a formula it is thus :— $\frac{A \times P \times S}{33{,}000}$ A equals piston area; P equals pressure of steam, and S is the speed of the piston per minute. Now applying this rule to our engine, we have $\frac{28{\cdot}27 \times 40 \times 200}{33{,}000}$ and the resulting figure is very nearly 7. This power is run very fine, very little margin being allowed for contingencies; but as the engine will readily bear 50 lbs. steam instead of 40, that would of course raise its power by one-fourth, making it nearly 9 indicated horse-power, and this would amply suffice. In our last paper we put the area of grate down at $3\frac{1}{4}$ square feet on the calculation that about 6 indicated horse-power would suffice, but we also counted on the fact that a 6 nominal would work to 9 actual, and indeed the proportions we selected in our first paper[1] work out as we have just seen at something like 7 indicated if 40 lbs. steam reach the cylinder, and that 50 lbs. would cause it to develope about 9 indicated. This increase, however, depends on the capacity of the boiler to make steam as well as on the engine to use it; consequently as a matter of common sense a boiler of sufficient size to steam an engine indicating 9 horse-power must be put down, and here we can compare theory and practice by contrasting our calculations with the measurements of a boiler actually made and used. This boiler is of the return tube type, and its leading dimensions are as follows :—

Length of barrel, or shell . .	5 ft. 0 in.
Diameter outside plates . .	3 „ 9 „
„ fire flue, inside . .	1 „ 8 „
Length of fire flue	3 „ 3 „
Number of tubes	20
Outside diameter	$2\frac{1}{4}$ in.
Length	3 ft. 3 „

If our readers will refer to the sketches figs. 7 and 8 they will find a rough sketch as nearly resembling the one we have

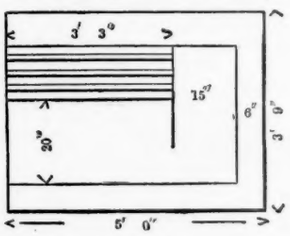


Fig. 7.

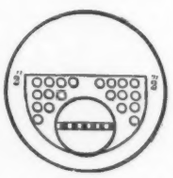


Fig. 8.

above adverted to as our engraver can make it. We will in our next paper show the same boiler drawn to a regular scale, so that our student readers may be able to verify some parts of the following calculation for themselves. We content ourselves at present with simply giving a portion of the calculations in detail, and all the totals, desiring that our readers may exercise themselves a little in a really practical application of those rules and instructions in mensuration they learned during their school and college curriculum.

Taking the tubes first, we proceed to calculate their heating or actual surface, and we take up any table of diameters and circumferences and find out in the column of diameters the figures $2\frac{1}{4}$; this being the diameter of our tubes, we refer to the circumference column and there we find the figure to be 7·06, or for all practical purposes in round numbers 7 inches; we may therefore just state the sum thus, $\frac{20 \times 39 \times 7}{144}$ it being the number of tubes, their length in inches, and their circumference mutually multiplied and the total divided by 144, or the number of square inches in a square foot. We find the answer to be 38. Next for the fire flue; this taken in the same way gives us $\frac{62{\cdot}8 \times 39}{144}$ or 17. The combustion chamber (A, fig. 7) taken in detail shows the crown or top to equal 3'·75; the sides and bottom 9'·30; the back C, 6"·2 and the front D, into which the tubes are set, 3'·0; all these totted up give a total of 77·25. If we divided this by the trade value of the power of our engine as estimated in inches diameter of cylinder, we should have $\frac{77{\cdot}25}{6}$ or 12·87 nearly as the area of heating surface allowed per "nominal;" taking our engine, however, as having to indicate perhaps 9, then $\frac{77{\cdot}25}{9}$ gives 7·47 nearly, which is a large allowance; it must, however, be borne in mind that from the semicircular shape of the crown of the fire-box or flue, which is over the grate bars, and which has nothing to do with the combustion chamber, the combustion of the fuel is not very perfect here, and an ample cross section area of tubes must be given in order to make up for the defective form of the air space at the furnace, because the products of the distillation of the defectively burnt fuel will burn in the combustion chamber if mixed with a sufficient quantity of oxygen, and as this cannot come in below unless the draught is sufficient, the tube cross section, or tube area, must be thought of as well as the heating surface. The tube area in this boiler is 3·1 × 20, or 62 square inches, the bore of a $2\frac{1}{4}$ inch tube being only about 2, the corresponding area is 3·1. This area indeed is not actually sufficient, and consequently it is a defective feature in this class of boiler because a sharp draught has to be maintained, so as to cause the gases and products of combustion to pass rapidly along to make room for those succeeding them. The area of the grate of this boiler is about $4\frac{1}{2}$ square feet, or about $\frac{3}{4}$ of a foot per "nominal" horse-power of 6; and $\frac{1}{2}$ a one per "indicated" of 9 horse-power.

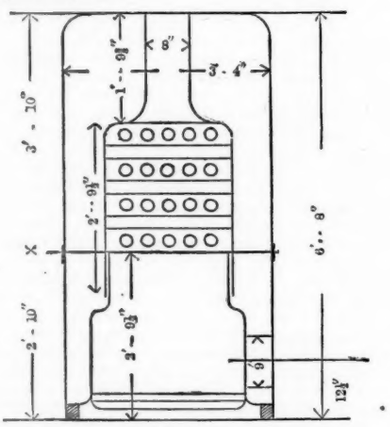


Fig. 9.

We now proceed to put another type of boiler before our students, viz. a vertical of the most improved construction; leading dimensions of this are :—

Height	6 ft. 8 in.
Outside diameter	3 „ 4 „
Number of tubes	35
Outside diameter	3 in.
Length between plates . . .	2 ft. 1 in.
Area of grate	$5\frac{1}{2}$ sq. ft.

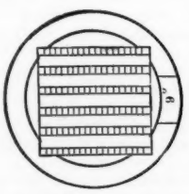


Fig. 10.

Then proceeding to calculate the heating surface we work thus, taking the tubes first, $\frac{35 \times 9{\cdot}42 \times 25}{144}$ this yields us 57 square feet. Next, the tube chamber or square box within which the tubes are set; we have only to take the height multiplied by the breadth, this multiplied by four gives the surface, from which, however, we must deduct the tube ends, two to each, or 70, and the area of the bore of a tube 3 inches outside diameter being about 6 inches, we have $\frac{70 \times 6}{144}$ or $\frac{420}{144}$ = about 3 square feet; a quicker way to compute this is to take the 6 inches as the 1-24th of a square foot, and 24 will nearly go into 70 three times, so we reach the same result by another and different road. Well, then, to return, if our readers will refer to

[1] "Practical Magazine," August, 1874.

rough sketches figs. 9 and 10 they will see the height of the tube chamber marked; it is in round numbers 2′ 10″ including, of course, the clear vertical height not merely of the tube plate but measured to a straight edge placed on the upper surface of the crown plate. The total heating surface in this boiler, which is from an actual practical design, is 98 square feet, which, allowing the large area of 14 square feet for a horse-power nominal, equals in round figures 7. We advise our readers to set out both boilers with their drawing instruments and boards, &c., and this will make all we now write clearer to them; in our next paper we leave the region of mere preliminary calculations which we have now made as clear as we can in magazine articles, and reach the next stage, which will treat of the actual designing of our pumping engine, or at least of designing individually each portion of it, showing as we proceed how these various parts are fitted together, and in the interim we strongly counsel our student readers to study carefully and think out all the bearings of the principles we have as yet tried to elucidate for them. Neither mere superficial reading on the one hand, nor committal "parrot fashion" to memory on the other, will impart that real useful practical knowledge of mechanical engineering to our readers we so earnestly desire they should receive.

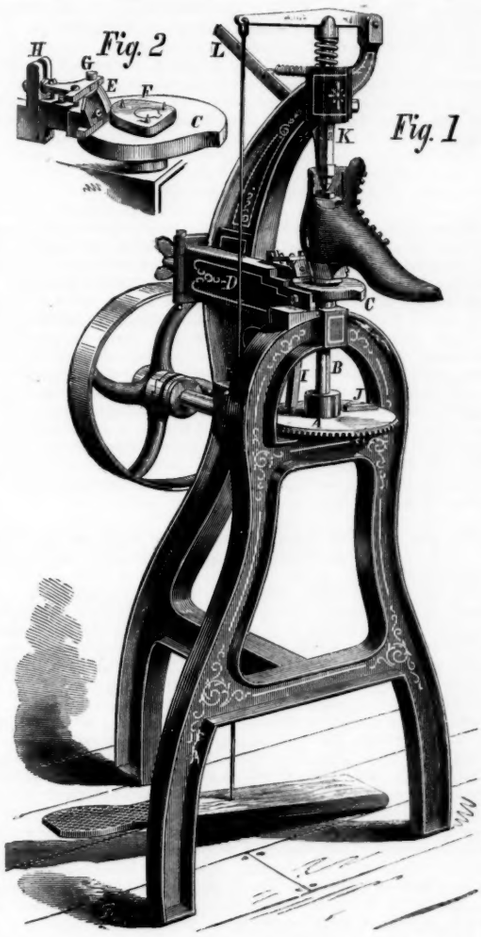
JONES' HEEL-TRIMMING MACHINE.

IN the invention represented in our illustration are combined a variety of novel and ingenious devices which, together, form an improved machine for trimming shoe-heels. The motive power may be steam, in connection with a pulley, or hand labour, employed through a crank. Upon a horizontal shaft is a bevel gear wheel, A, which rotates the vertical shaft, B. At the upper end of the latter is a double cam plate, C, the edge of which is suitably shaped to allow the arm which carries the knife to move onward at the proper time. The arm works in the casing, D, and its outer end is pivoted to a plate attached to the rear part of the frame. Upon its inner side is formed a socket to receive the knife-bar, into which is adjusted a screw rod (operated by a thumb-nut, shown at the rear) which limits the movement of the knife, and also serves as a guide for a coiled spring, by which the latter is held out to its work.

In fig. 2 the cam plate and cutting mechanism are represented on a larger scale. E is the knife, in front of the right-hand lower corner of which projects a finger, which rests against the guide, F. The latter is secured detachably to the shaft, B, above the cam plate, as shown. It is of the exact form of the required heel, and must be changed for differing sizes of the same. On the upper side of the knife bar, at G, is a gauge, which presses against the counter, and, projecting a little in front of the edge of the knife, keeps the same evenly around the seat of the heel. It may be raised or lowered to suit various heights of heels, and may be moved nearer to or further from the work by means of the screw operating in the slotted projection, H. There is also a washer under the guide, F, which varies the same, so that the knife may rest against it for the distance of an eighth of an inch or more, as desired.

To the forward end of the knife arm is attached a hook rod, which enters a groove under the cam plate. This portion of the device is necessarily hidden by other parts of the engraving. The object, however, is to cause the knife to move forward quickly, to cut the elongated sides of the heel, and slowly while cutting the short curve of the rear portion of the same. At I is shown the lower extremity of a drop or clutch, which is hinged to the frame at or near its middle, so that its upper end enters a socket on the under side of the knife arm. At a certain point of the revolution of the gear wheel, A, a stud, J, thereon comes in contact with the drop and carries the same partially around, thereby relieving the strain on the hook pin when it enters the short curve of the slot of the cam plate, at the same time serving as a brake.

The rear leg of the frame projects upward and curves forward, so that its upper extremity is directly over the vertical shaft, B. Through this upper end passes a shaft, K, which connects with a spring lever above. The latter is operated by the treadle shown, and the device serves to hold the shoe down upon the guide. Near the lower end of the shaft, K, is a joint worked by the lever, L, the object of which is to trip the shoe, when it becomes necessary to give one part of the heel more bevel than another. The knife, besides, has a spring upon its inner side, which will allow of its conforming to all ordinary styles of heels without requiring the employment of the tripping lever.



The mode of adjusting the shoe to be operated upon is already shown in fig. 1. The pulley is operated over about 2½ revolutions to trim the shoe, and the speed required is some fifty revolutions per minute. *Scientific American.*

Chemistry applied to the Arts, Manufactures, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

§ 1. *Acids, Alkalies, and Salts.*

CHEMICAL Substitution of Alkalis in the Ashes of Plants.—In a paper communicated by the French Academy of Sciences, and published in the "Comptes Rendus" for March, 1875, MM. CHAMPION and PELLET showed that the quantities of sulphuric acid requisite for the separate saturation of the several alkalies contained in the ashes of beet (leaves and roots), varied within tolerably wide limits, although their sum remained notably constant, showing, in other words, that a partial substitution of these alkalis sometimes takes place in accordance with their chemical equivalents.

Subsequent researches have led MM. Champion and Pellet to believe that this law holds good with most if not with all plants. They give a table of analysis of wheat (grain and straw), rye and barley (grain of each), maize (grain and straw)

haricots, peas, mustard, flax, and *lolium perenne*, by Bichon, Boussingault, James, Johnston, Kœchlin and other authorities, showing that the potash and soda, as well as the lime and magnesia, occasionally replace one another, according to their chemical equivalents. As a rule, this substitution includes all alkalis. Subsequent analyses of beet and various tobaccos have confirmed the above view. *Comptes Rendus, lxxx. 28th June*, 1875.

§ 2. *Metallurgy.*

Effects of Cold on Iron.—At a meeting of the Academy of Sciences of Philadelphia, in the course of the past winter, Mr. WILLARD referred to two instances of the brittleness of iron under the prevailing even temperature that had come under his notice the day previous. In breaking up an old locomotive, the cutting off of the rivet heads, which usually requires heavy sledging, was effected at a single blow, as if they were made of cast-iron. In the forging of a long steamboat shaft of the best hammered iron, which hung balanced in a crane, the hammering of the heated end caused vibration of the overhung end which would have been insignificant at ordinary temperatures, but at 10° Fahr. proved sufficient to cause the beam to break off sharp near the point of support. The published tests of iron and steel show no loss of tensile strength at low temperatures under a gradual stress, but all experiments show a great loss of *body*, or ability to resist a blow.

Preparation of Gold-Powder. Either of the following methods may be pursued by those who desire to prepare this article for themselves.

M. Robert's Method. Put some gold-leaf in a saucer; add thereto a little honey; pound well together with a glass stopper, the base of which presents a flat, smooth surface; throw the paste thus obtained into a glass of water containing a small quantity of proof-spirit, wash it and leave it therein. Decant the liquor and again wash the precipitate, repeating the operation until a very fine, pure, lustrous gold powder is obtained. Mixed with sea-salt and cream of tartar powdered and diluted with water, this powder can be used for gilding.

M. Boutil de Monrel's Method. In a sufficient quantity of aquafortis, placed in a porcelain capsule, and heated in a sand bath, dissolve 1 gr. of fine leaf gold; reduce it until it assumes the colour of bullock's blood. Add a half-litre of hot distilled water, in which 4 grs. of cyanide of potassium have been dissolved. Stir well with a glass rod and filter through blotting paper on a glass funnel. The potassium cyanide must be dissolved beforehand. The gilding process consists in cleaning the objects thoroughly, and placing them on a piece of clean zinc in a bath of gold prepared as above and gently warmed, where they are left for the space of ten minutes or more, according to the thickness of the gilding desired. *Les Mondes, 24th June*, 1875, *from Revue Hebdomadaire de Chimie.*

§ 3. *Dyeing, Calico Printing, Bleaching, Tanning, and Allied Subjects.*

Aniline Dyes as Tests for Distinguishing Vegetable Fibres. VITREBERT plunges the material in an aqueous solution of fuchsine or aniline blue, containing 1 decigramme of colouring matter to the litre of water. It is left therein for several hours, washed, and examined. Fibres of *phormium tenax* will be found highly coloured; those of hemp, flax, &c., remain white or unchanged. This test is much more decisive than nitric acid, and the reaction is not modified by bleaching. If the material is soaped after contact with the colouring matter, the contrast is still more marked; hempen fibres remain very white, *phormium* red. Attempts have been made to apply this test to paper, but the fibres are here so intimately intermingled that it is next to impossible to distinguish them. *Moniteur Indust. Belge, 1st July*, 1875.

Brown Ochre.—By the prolonged exposure to a cherry-red heat of a mixture of 110 parts of yellow ochre with 5 parts of common salt, a compound of a peculiar brown colour is obtained, which is roasted in a cast-iron retort, hermetically sealed, and so placed that the contents may be agitated from time to time. The duration of this operation, and of the subsequent cooling, sensibly affect the shade. The brown ochre thus obtained is well-adapted for ship-painting, and will be found very useful for that purpose, or wherever minerals suited for brown pigments are scarce. The cost of manufacture is 3 francs to 3¼ francs per 100 kilogs. *Revue Indust. 16th June*, 1875.

Scarlet, Salmon, and Rose on Wool.—The following is a recent receipt:—

For 50 kilogs. of yarn, the following bath is used: 5 kilogs. fine cochineal, 1·75 salts of tin, 3·125 oxalic acid, 5·0 tin composition, 0·125 flavine; boil for 15 minutes, cool; place the yarn in the mixture, raise it slowly to boiling point and keep it boiling for an hour. The result is a scarlet.

By adding 2·5 kilogs. oxalic acid and 1·25 kilogs. salt of tin, boiling, cooling, and treating the yarn as above, a salmon-colour is obtained.

If to the last bath 3 kilogs. of tin composition and 2 kilogs. of cochineal are added, and the mixture boiled and cooled, a deep rose colour is the result. The addition of 1·5 kilogs. of tin composition gives a light rose.

Too much flavine must not be added to the first bath, or the rose shades will not appear.

The tin composition consists of:—

27 litres	water.
15 kilogs.	nitric acid.
1·25 „	hydrochloric acid.
2·75 „	tin filings added to the acid, by small quantities at a time.

Technologiste, June, 1875, *from Springmühl's Muster-Zeitung.*

Ultramarine, Green, Blue, and Violet.—In a "Theoretical and Practical Study" of this colour, communicated to the Industrial Society of Mulhouse by M. Ernest Dollfus and Dr. Goppelsräder, the reporters observe that the present knowledge of the chemical compositions of ultramarine colours is very imperfect, notwithstanding the light thrown upon the subject by recent researches; amongst which may be especially mentioned those of Unger, given in the "Moniteur Scientifique Quesneville," October, 1874, and in "Dingler's Polytechnic Journal," 1872; 206, 371, and 1874; 212, 224, 301, and those of Reinhold Hoffmann, in "Wagner's Jahresbericht für Chem. Technologie," 1873.

Their own researches, although carried out with great minuteness, have not been much more conclusive. Making abstraction of the sulphate of lime mixed with the violet, the decomposition in dilute hydrochloric acid of the three sorts of ultramarine above specified was found to give different proportions of sulphur compounds. The green gave least, and the violet most sulphuric acid and sulphurous acid; the green yielded very little hyposulphurous acid, or none at all, whilst the blue furnished but one-fifth as much as the violet. The green gave most and the violet least sulphuretted hydrogen. By Hoffman's method of analysis, the blue was found to contain most, and the green least of the so-called free sulphur.

Whether the sulphur is present in the colour under these several forms, or whether the sulphurous and hyposulphurous acids, the free sulphur, &c. are merely the forms assumed by the sulphur during the decomposition of the ultramarine by an acid, according to Hoffmann's method of analysis, they are unable to decide. The latter method of analysis is perfect as regards the green, but less exact in its results in respect of the blue and violet, the difficulty being increased by the presence of hyposulphite, which is wanting in the green. Respecting the chemical formulas of the three colours of ultramarine the reporters are unable to express a positive opinion. They are unwilling either to single out for confirmation any hypothesis yet advanced or to broach a new one. They ascertained by various re-agents, as well as by quantitative analysis, that each of the three ultramarines, green, blue, and violet, has its own special composition, although the constituents of each are exactly the same, and the difference depends only on variations in the same class of compounds. The composition that appears to them most probable is that of a double silicate of aluminium and sodium, in which the oxygen is partially replaced by sulphur. But further researches, involving a considerable expenditure of time and patience, are needed to set the question definitely at rest. These three colours, although they may be in a chemically pure state and free from all admixture of foreign matters, still present great difficulties in the way of determining with certainty their molecular formula,—difficulties caused chiefly by insolubility of the colours in ordinary solvents and their behaviour in the presence of the most energetic reagents. Moreover, it has been hitherto found impracticable to obtain ultramarine in a crystallized state (Buchner, "Berichte der D. Chem. Gesellschaft," 1874, No. 12).

In conclusion, the reporters observe that, vast as have been the strides made by organic chemistry in our day, the ultramarines certainly afford a striking example of the problems that remain to be solved by inorganic chemistry. *Bull. de la Soc. Indust. de Mulhouse, May*, 1875.

Certain Effects of Ozone and of Frost on Dye-Stuffs.—In a note on this subject, addressed to the same

Society, and accompanied by samples, Dr. Goppelsräder writes :—

"Last winter, M. Camille Kœchlin communicated an interesting fact in connection with some pieces of indigo-dyed calico. After having been passed through a bath of dilute sulphuric acid, these goods, instead of being dried, had been hung up wet, and, it being winter-time, had got frozen. Subsequently they showed signs of discoloration, chiefly along the edges. At M. Kœchlin's request, I made a further investigation of the circumstance in the laboratory.

"As the goods had only been exposed to the action of water and atmospheric air, at a temperature low enough to freeze the former, the cause was to be sought in one or other of these three influences, or in their conjoint effect on the contents of the dye vat. No. 1 is a sample of the blue-dyed fabric given me expressly for those experiments by M. Kœchlin. The colouring is perfectly homogenous. No. 2 is a sample of the same on the surface of which I froze repeatedly considerable quantities of distilled water. It is somewhat discoloured and spotted, especially on the side that was exposed to a current of air from the back-yard ; the other side, that hung facing the wall, is less affected. The spots somewhat resemble the crystallization of ice as observed in the frosting of glass windows. Under the microscope, the fibres of the cotton are seen to be much disarranged. On No. 3, which had been exposed in the same way for several days, the differences between the effect in air in motion and air in a more stagnant condition, and between the sunlights and shade, are more distinctly perceptible.

The atmospheric agents requiring consideration are :—1. Free oxygen, changed by various causes into ozone, which is constantly present in the atmosphere in greater or less quantity. 2. Antozone in combination with oxygenated water. 3. Nitrite of ammonia. 4. Nitrate of ammonia. That the small quantity of nitrate of ammonia present in the air, or produced by the evaporation of water at a lower temperature, could not have sufficed to produce the effects shown in samples No. 2 and 3 is proved by another sample, No. 5, which was soaked for some length of time in a concentrated solution of nitrate of ammonia, and afterwards allowed to freeze. The colour is lighter than before and spotted, but the effects are not nearly so marked as where water alone was used. The same result was observed in sample No. 6, where nitrite of ammonia was used in the same way. A strong solution of oxygenated water produced no effect on No. 7. It was as though the antozone had destroyed the ozone, and nullified its effect. Free ozone, at ordinary temperatures, had no effect on dry tissues, as seen in sample 8 ; but, by its action, it discolours tissues that have been wetted. Lowering the temperature below freezing-point does not interfere with the action of the ozone, if the material has been wetted with water. No. 10 sample was kept wet and exposed in a horizontal position to the action of ozone, liberated by the atmospheric action of phosphorus, at a temperature below freezing-point. The under side showed the effects more than the upper.

"My researches have led me to conclude that the free ozone in the atmosphere is the principal cause of discolouration of the indigotine. The effect is most marked on those parts of the tissue that have been most exposed to its action. But the crystallization of the water in freezing also exercises a powerful effect on both the colouring matter and the fibre.

"Vat blue is not the only colour that suffers in this way. But the several atmospheric agencies, physical or chemical, differ in their effects according to the nature of the fibre and of the colouring material. The state in which the colour is present, whether pure or in combination with a mordant, also influences the results.

"In the experiments made with various colours, the ozone was produced by exposing melted phosphorus to the air ; the ozonized air was also freed of all traces of phosphorus or phosphoric acid. A few examples of the results obtained may be cited. In every case the material was first wetted, and then plunged in an atmosphere of ozone. Cochineal red on wool was much lightened by a week's exposure to the action of ozone, but was not discoloured. Aniline black remained unchanged. The materials were not sized to avoid the influence of the acid generated by the action of the ozone on the mucilage. Aniline brown on cotton turned orange. Fuchsine rose, violet, and Hoffmann's blue were slowly discoloured, as were also coraline red and iodine green. A series of colours obtained from lacs of dyewoods and also Turkey red were discoloured. A material with a black and grey pattern on an artificial alizarine red ground gradually lost its red colour and turned white, whilst the black and grey pattern resisted. Fleur-de-garance violet discoloured very quickly, leaving behind a yellowish tinge. Madder-dyed calicoes with red, pink, black, violet and brown stripes, after a certain amount of exposure, presented a light red tinge on the parts mordanted with alum, a dirty violet brown on those mordanted with iron for black, and a dirty brownish red on those mordanted with a mixture of iron and alumina, whilst the violet bands presented only a light yellow shade due to the iron mordant.

"All the organic colours examined resisted the action of the ozone, when no water was present. On all, artificial as well as natural, the damp ozone caused an energetic action.

"Ozone or active oxygen, although not prepared artificially for the express purpose, nevertheless plays an important part in the bleaching of textile fibres. Meadow bleaching depends chiefly on the action of ozone, either free or in combination with nitrite or nitrate of ammonia and on oxygenated water, all of which are formed during the exposure of the wet tissues to the air. The cheap production of a feebly ozonized atmosphere, so that the fibre of the material might not suffer, would admit of useful applications not only in certain kinds of bleaching, but also in the production of certain colours in a much shorter time than in atmospheric air.

"I now present to your notice an aniline black produced by printing with a mixture of the hydrochlorates of aniline and ammonia thickened with sulphate of copper and chlorate of potassium, and exposing to an atmosphere of ozone. The black was developed, in the several trials made, in the course of an hour or an hour and a half. I thought at first that the accelerated action might prove injurious to the tissue, but, on the contrary, the rapid development of the colour appears to be beneficial.

"The best method of producing ozone would perhaps be with the aid of a gramme machine. By passing an electric spark through a conductor broken into a number of points sufficient ozone could no doubt be generated without the use of phosphorus, which is not altogether devoid of danger.

"In the galvanic decomposition of water considerable quantities of ozonized oxygen are produced at the positive pole, and this might perhaps be effected by a gramme machine. The piles now in use give very good results, but they are too costly for the purpose.

"I hope shortly to acquaint you with some interesting particulars of the action of the galvanic current on organic substances of various kinds, more especially on aromatic substances, and to show you the products thus formed at each pole, which must possess considerable interest for chemists who devote themselves more especially to the study of colouring materials.

"The effects of frost on colours and mordants, on lacs, thickening, and mucilages, on fabrics coloured or uncoloured, bleached, mordanted, dyed or printed, are deserving of careful study. The effects may be chemical or mechanical. We know the ill-effects of frost on alizarine paste, on preparations of alumina, on cochineal lac, on mordanted tissues, &c. These facts have not as yet received sufficient explanation from science. I would beg the members of our society to apprise me of any facts relating to the detrimental action of frost on any portion of the processes in dyeing or printing which may come under their notice." *Bulletin de la Soc. Indust. de Mulhouse, May*, 1875.

New Aniline Black.—By a process patented by M. GRAWITZ, aniline blacks of various shades, passing from a blue to a claret-black, and from a violet to a full intense black, are obtained by the reaction of aniline oil on some one of the salts of iron or copper, at the maximum of oxidation. Ferrous or cuprous aniline is thus produced, which oxidises readily with chlorate of potash or soluble chromate, giving a fine colouring material well adapted for colour-printing, dyeing, the fabrication of varnishes, inks, and the like. Amongst the various materials employed preference is given to the following :—1. Sulphate of copper, potassium dichromate, oil of aniline. 2. Proto-sulphate of iron, potassium dichromate, oil of aniline. In place of the oil a neutral salt of aniline may be employed. In a recent addition to the patent, certain modifications of the earlier processes of printing and dyeing are introduced. *Moniteur Indust. Belge*, 10*th July*, 1875.

Blue on Linen and Woollen Yarns and Fabrics without Indigo.—L. WAGNER, dyer, of Offenbach near Landau, recommends the following method :—

The material is first boiled for 1 or 1½ hours in soda lye, and afterwards, without washing, is passed through dilute muriatic acid, washed, and dried.

The colour bath for 3 litres of medium blue is composed of 40 gr. chlorate of potash, 40 gr. chloride of copper, 80 gr. muriate of aniline, 13 gr. sulphate of aniline, 13 gr. blue vitriol. It is prepared as below, lighter or darker shades being produced by varying the above proportions.

Potato starch is boiled for six hours in dilute sulphuric acid, neutralized with soda or potash, until it no longer reddens blue litmus paper, and has acquired the consistency of honey. About 2 lbs. of acid and 4 lbs. of soda are allowed to 40 lbs. starch.

When perfectly clean, half a litre of this thickening is boiled with 40 gr. of wheat starch, and, whilst warm, the chlorate of potash is stirred in. With another half litre the preparations of aniline are mixed. Then the chlorate of copper and the vitriol are separately mixed with 2 litres of thickening, and all are mixed together to form the dye bath. In this the material is well worked, and allowed to remain for the space of one hour. It is then taken out, and hung up for four hours in a steam chamber, at a temperature of 167° Fahr., and afterwards laid for two hours in a cool, damp place. Next, it is laid for a quarter of an hour in lime water, containing 2 lbs. of lime to 50 lbs. of material, which brings out the blue colour. Finally, it is washed, first in dilute muriatic acid or lukewarm soda water, and afterwards with soap and water. *Bayerisches Indust.- und Gewerbe-Blatt, May*, 1875.

Indigo Culture in India.—The cultivation of indigo has increased in Bahar, whilst its area has diminished in Bengal. In Maldah, Murshedabad, and Rajshahe, the constant changes in the River Ganges supply ample alluvial soil, well adapted for indigo crops. In Maldah alone there are twenty working factories, turning out 2,000 maunds. But one-half the exported produce is from Bahar, and almost entirely from the districts on the north side of the Ganges, Tirhut, Champanun, and Saran. In 1872-3, the export of indigo from Calcutta amounted to 162,860 maunds, worth £2,704,408. In the year ending March, 1872, the export of indigo from British India was 115,414 cwts., which was a small increase on the previous years.

§ 4. *Food, Water, and Sanitary Matters.*

Hydrometric Equivalents.—The undernamed journal gives the subjoined table of the corresponding degrees of hardness in water, reckoned according to the methods severally in use in France, in Germany, and in England :—

Degrees of Hardness in Water.

France.	Germany.	England.
1°	0·56°	0·70°
1·5	0·84	1·05
2	1·12	1·40
2·5	1·40	1·75
3	1·68	2·10
3·5	1·96	2·45
4	2·24	2·80
4·5	2·52	3·15
5	2·80	3·50
5·5	3·08	3·55
6	3·56	4·20
7	3·92	4·90
8	4·48	5·60
9	5·04	6·30
10	5·60	7·00
11	6·16	8·4
12	6·72	8·7
13	7·28	9·1
14	7·84	9·8
15	8·40	10·5
16	8·96	11·2
17	9·52	11·9
18	10·08	12·6
19	10·64	13·3
20	11·20	14·0
21	11·76	14·7
22	12·32	15·4
23	12·88	16·1
24	13·44	16·8
25	14·00	17·5

Moniteur Indust. Belge, 20th June, 1875.

Disinfection of Waste Water.—At a recent meeting of old pupils of the Ecole Centrale at Lille, some interesting information was furnished respecting the application of Béranger and Stingl's water-purifying process to the disinfection of the waste water of industrial establishments. The apparatus used is the same as in purifying, but different reagents are used.

The case of Lœsing's great brewery at Vienna, where what is known in Paris as "Bière Fanta" is made, was cited. This establishment discharges daily 1,000 cubic metres of water, and had so effectually poisoned a charming stream running through a district studded with villas and country houses, that the compulsory closing of the works was imminent. At this juncture MM. Béranger and Stingl arrived on the scene, and succeeded in precipitating the whole of the organic and other matters contained in the water, by the use of small quantities of sesquichloride of iron, obtained by treating hydrated iron ore with hydrochloric acid. When the precipitates are required for manure, either some iron mineral or phosphoretted alumina is employed instead, and the water filtered through straw. It comes out colourless and inodorous, and the residua are fit for use as manure without further preparation. *Revue Indust. 7th July*, 1875.

Effects of Chemical Manures on Seed-Beds.—In a report on the late Vienna Exhibition, M. MATHIEU gives the following account of experiments with chemical manures, made at the Prussian Forest School at Neustadt-Eberswald in 1872. The seed-beds were in a forest-clearing, at an altitude of 1,220 metres, with a south-west aspect, and a light sandy soil resulting solely from the decomposition of the underlying rock, a micaceous tulcose schist containing quartz, and a little feldspar. The surface-soil is poor in soluble salts, a deficiency which attempts had been made to supply by a top-dressing of peat-ashes. The manure employed was Ville's chemical manure, No. 4, having the following composition :—

Superphosphate of lime	40·00
Nitrate of potash	83·34
Sulphate of lime	26·66
	100·00

It was applied as a top-dressing on 1st August, *i.e.* before the second movement of the sap.

1st Experiment. Beds sowed very thickly with *epicea*, three-years old young seedlings pershing, one-third already dead. Manure sprinkled over, on 1st August, in proportion of 30, 25, or 20 gr. per square metre. Water afterwards given overhead to wash the dust from the leaves. On 1st September, the plants had assumed a green hue, which was noticeable on the lower portions even of the sickliest, whence it gradually spread to the tops. On 1st October all the seedlings so treated presented an uniform deep green hue, whilst those that had received no manure were yellow and in some places withered outright. Twelve months later, the beds treated with the manure furnished fine healthy seedlings, in the proportion of 5,000 to the square metre, whilst the beds not so treated furnished at most 1,000 suitable plants in a like space. The maximum of useful effect was produced with 30 gr. of manure to the square metre.

2nd Experiment. The same soil mixed with a large proportion of leaf-mould and peat-ashes. Sown with firs and *epicea*, two months old. On 1st August, the seed-beds were dressed with the manure, in the proportion of 15 gr. per square metre. No effects were perceptible ; which perhaps was due either to the large proportion of leaf-mould present, or to the feeble proportion of manure employed.

Without attempting to deduce general conclusions from insufficient data, there appears reason to believe that chemical manures may often prove of essential service in the treatment of unhealthy seedlings. *Les Mondes, 24th June*, 1875.

Influence of Compressed Air on Ferments.—Some years ago, M. P. BERT communicated to the French Academy the results of experiments tending to show that the fatal effects of excessive atmospheric pressure on living organisms were due to the high tension of the oxygen so caused, and not to the physico-mechanical action of the air.

M. Bert has since investigated the effects of compressed air upon ferments, and has arrived at the following conclusions :—

1. Fermentations proper, resulting from the development of certain organic growths, are permanently arrested by exposure to a sufficiently high atmospheric pressure. The organisms are killed outright.

2. Diastasic fermentations are wholly unaffected by exposure to such pressure, no matter how great or long continued.

Fermentations properly so called. Amongst fermentations of this class, perhaps the most interesting is putrefaction, which Pasteur has shown to be caused by the action of animalculæ of the group of *vibriones*. Compressed air, according to the degree of pressure employed, either checks or permanently arrests putrefaction and the oxidations which accompany it, as the following experiments show :—

A piece of muscle weighing 95 grs. was subjected to a pressure of 25 atmospheres, in common air, from 29th July to 3rd August. At the end of that time no smell was perceptible in it, and it had consumed no more than 380 cubic centim. of oxygen. A similar piece, having been put under a bell-glass during the same time, became stinking and covered with mould. It had consumed 1185 cubic centim. of oxygen. Another piece of muscle weighing 45 grs. was exposed to a pressure of 44 atmospheres, in air containing 88 per cent. of oxygen. At the end of that time, the meat was perfectly devoid of smell, and no traces of the absorption of oxygen or the formation of carbonic acid were perceptible. A

similar piece hung up in ordinary air during the same period became completely putrid, and absorbed 3½ litres of oxygen. Meat so treated retains its original appearance and structure. The colour, however, changes, turning to a sort of amber yellow. Mutton cutlets kept for a month in oxygen, at a pressure of 44 atmospheres, were found to be quite eatable, but had a slightly insipid taste. Meat thus treated will keep for an indefinite period after the normal atmospheric pressure is restored, so long as it is protected from a fresh contact with atmospheric impurities. The putrefaction of eggs may be prevented in like manner. Wine so treated remains unaltered as regards the proportions of alcohol and acetic acid, but fermentation is arrested, and if the pressure be not too great, the wine acquires an agreeable taste of age. Compressed air also prevents the putrefaction although not the coagulation of milk. This is probably due to the rapidity of the latter, whilst the compressed air requires a certain time to make its effects felt. Meat and eggs after long exposure to compressed oxygen exhibit a well-marked acid reaction, due apparently to lactic acid; in amylaceous substances subjected to like treatment, acetic and formic acid appear to be also present.

Diastatic Fermentations.—Saliva, pancreatic juice, vegetable diastase, pepsine, the inverted ferment of yeast, and other similar matters, were exposed to the influence of compressed air, in air-tight vessels. They remained wholly unchanged during and after the removal of the pressure.

Here, it would seem, is a simple and reliable method of preserving animal secretions, which is likely to prove of essential service in therapeutics.

It is suggested also that the behaviour of certain substances under the influence of compressed air would furnish a new and valuable method of physiological analysis. For example, it is still a moot question whether or not the blood in certain cases of infectious disorders, animal poisons, various pathological liquids and the like, owe their action to the pressure of corpuscles resembling organic ferments or to certain chemical changes analogous to diastasic fermentation. The action of these several matters under the influence of atmospheric pressure should throw important light on this question. *Comptes Rendus, lxxx.* 25, *28th June*, 1875.

Microscopic Examination of Pork.—At a meeting of the Medical Section of the Silesian Gesellschaft für Vaterländische Cultur, on the 4th ult., M. TIEMANN read a paper on the necessity of compulsory microscopic inspection of pork before sale, as a safeguard against trichinosis. M. Tiemann showed that many difficulties now arise from such inspections not being compulsory, and that matters are further complicated by the use of a higher microscopic power than really is necessary being held indispensable in doubtful cases. That the use of a high power, although it involves a much greater expenditure of time and trouble, does not necessarily afford greater security is now proved by the fact that hams examined with a power of 20 diameters and declared sound, have been afterwards found to contain trichina when tested with a lower power. M. Tiemann recommended that a preliminary examination of the kind in question, by an officer appointed for the purpose, should be made compulsory. He considered a common microscope with a power of 10 to 12 diameters would be sufficient for the purpose. A sample of flesh of not less than 22½ square inches, to be cut from two separate places on every whole carcase, and of not less than 14 square inches from each ham offered for sale; such samples to be tested in the aforesaid manner, on the spot. A charge of 12 sgrs. to be allowed for each carcase, and 5 sgrs. for each ham offered for sale, which should go to provide remuneration for the inspectors and the vendors, and to cover other necessary working expenses. M. Tiemann's suggestions met with the unanimous approval of the meeting. *Industrie-Blätter, 8th July*, 1875, *from Breslauer Zeitung*.

Machine for Corking Bottles containing Effervescing Drinks.—A simple and apparently effective machine for this purpose, which can be worked by one person, is figured in the undermentioned journal. Particulars can be obtained from the inventor, M. SCHMIDT, No. 8, Springgate, Copenhagen. *Industrie Tidende (Copenhagen), 16th May*, 1875.

Utilization of Pine Cones.—We have received from M. Triossi of Ravenna (Italy) a circular showing some of the uses of the cones of the pine of the south of Europe. The edible seeds of the pine cones are in most instances preferred to almonds, in consequence of their more delicate and aromatic taste, and more moderate price, which ranges from 125 to 150 fr. (£5 to £6) per 100 kilogs. according to the abundance of the yield. The first quality *pignons* or pine-seeds, with their shells, are chiefly consumed in steamboats during long voyages, and for dessert at the principal hotels, either by themselves or mixed with Sicily almonds, to which they are considered superior, owing to their exquisite taste. They are sold in the shell, or unhusked, at 60 to 75 fr. per 100 kilogs. They are shipped in small cases of 20 to 50 kilogs. The pellicles of the pignons are generally employed for filling mattresses for hospitals, useful in certain skin-diseases and also for infants' beds, because they are salubrious and prevent bad odours and humidity. These pellicles are sold at 4 fr. per kilog. Owing to their lightness 10 kilogs. are required for a mattress, and 2 kilogs. for a child's bed. The pine cones, which furnish the seeds of the late crop, not having been opened by the sun, serve for protecting cloth garments and furs from the moth, if enclosed therein. They are sold of good quality at 2½*d.* each. M. Riossi is the concessionnaire for ten years for the pine-cones of the forests of Rossori and Tombelo, Pisa belonging to the King of Italy and the pine forests of Ravenna belonging to the State, and he is extending their use by diffusing information respecting them. *Journal of Applied Science.*

Concentrated Beer.—A new process—entirely different from that employed in making beer from solid or condensed wort—has lately been perfected and patented by Mr. P. E. Lockwood, sometime connected with the English and Swiss Condensed Milk Companies. The process is comparatively simple, though the result possesses considerable interest, and is likely to effect a great modification in the export trade.

Beer or stout is taken in any stage of fermentation, though the process is better applied when it is fit for drinking, and evaporated in a vacuum-pan, until a large part of the alcohol and water is distilled and the beer or stout is reduced to a thick viscous fluid of about the consistency of treacle or condensed milk. The alcohol and water of course pass away in vapour, which in its turn is condensed in a receiver attached to the vacuum-pan, and the alcohol is obtained by re-distilling the liquid taken from the receiver, or a rectifying still may be attached to the vacuum-pans, and the whole process performed at one operation. This alcohol may be remixed with the condensed beer, either before the latter is enclosed in tins or receptacles, or at any time afterwards. By the process of condensation the beer or stout is reduced to one-eighth or one-tenth of its original volume, according to the original strength, and as fermentation is arrested by the heat employed, the condensed mixture may be depended upon to keep good for any length of time, in any climate. The process of re-making the beer, *i.e.* the re-conversion of the mixture into beer, is also a simple one, consisting merely in adding the bulk of water originally abstracted, and setting up fermentation again by a small quantity of yeast or other ferment. Within about forty-eight hours the beer may be drawn from the tap for use or bottled in the ordinary way; or without the addition of yeast or any other ferment, the beer may be bottled and charged with carbonic acid by machine, like aerated water. The chief value of the process consists in its adaptation to any kind of beer, so that lighter and cheaper beers will be capable of exportation, in a condensed form, to tropical and semi-tropical climates and there remaking, the quality of the added water having little effect on the beer, so long as the latter was originally brewed with water suitable for the purpose. *Abridged from Standard Newspaper.*

Test for Free Carbonic Acid in Potable Waters.—Professor PETTENKOFER, of Munich, advocates the use of "rosolic acid," prepared according to Professor Kolbe's method, by treating a mixture of carbolic and oxalic acid with sulphuric acid, as the surest test for the presence of *free* carbonic acid in water in a natural state. A solution of 1 part of rosolic acid is made in 500 parts of spirits of wine of 80 per cent. To 50 cubic centm. of the water to be tested, in a test-glass, is added ¼ cubic centm. of the solution. Trials of the water from all sources in the neighbourhood of Munich, and of mineral waters of all descriptions, have shown that when carbonic acid is present in a *free* state, the water remains colourless, or with a yellowish tinge only. When the carbonic acid exists in a *combined* form only, the water acquires a red colour by the addition of the acid. *Bayerisches Ind.- u. Gewerbe-Blatt, May*, 1875, *from Reports of Bayerische Academie der Wissenschaften, No.* 1, 1875.

Milk Analysis.—A writer in the "Journal of Applied Science" states that he has been unable to discover any analysis of the milk of a *carnivorous* animal, although, doubtless, such have been made. It would be interesting to see in what way the milk of an animal, whose food was entirely flesh, might differ from that produced by animals wholly graminivorous.

In considering such analyses of milk it must be remembered that they are only approximative. The milk of various individuals of different species, and even of different individuals of the same species, varies within considerable limits, according to the circumstances under which the individual was existing at the time it was produced.

§ 5. *Fuel, Heating, Illumination, &c.*

Manufacture of Illuminating-Gas with Superheated Steam. — Professor POILLON, of the Industrial Institute, Lisle, describes a method of manufacturing illuminating-gas from coal with superheated-steam, which is safe, economical, and well adapted for small establishments. The coal is broken small, placed in a cylindro-conical retort, and treated with superheated-steam laid on from an ordinary steam-generator. The steam acts in two ways : its heat supplies the place of firing, in converting the volatile portions of the coal into gas ; and its *vis viva* carries the gas forward into the gasometer. Steam at an elevated temperature has most of the properties of a permanent gas, and enters into a state of very intimate admixture with the coal-gas. On its subsequent condensation it carries down with it all the soluble gases, as sulphuretted hydrogen, ammonia, and other impurities, which would be detrimental to illumination, so that it only remains to pass the gas through ordinary water for it to be ready for use. *Moniteur Indust. Belge, 20th June*, 1875.

Cheap Illuminating-Gas from Hydrocarbonates. —The undermentioned journal figures an improved apparatus for the distillation of illuminating-gas from schist-oils, petroleum, and other hydrocarbonates, which is said to be especially adapted to meet the requirements of small industrial establishments manufacturing their own gas. It is the invention of M. Du Rieux, the apparatus figured having been erected by M. Duvilder of Cambrai. The oils are distilled in one or more upright cast-iron retorts 150 millm. (6 in.) in diameter and 1·8 m. (5 ft. 10 in.) high, provided with spiral diagrams to regulate the movement of oil, and set in a brick furnace. These retorts can be used singly or collectively as required. At M. Ménard's establishment, at Solesnes, where the experiment was first tried in 1864, the cost, including interest on outlay, and allowing 10 per cent. or 2 fr. 15 c. per diem for deterioration of apparatus, is reckoned at 8,000 fr. or less than 0·03 fr. per gas-jet per hour. With the Autun schist-oils, which can be delivered in Paris, carriage paid, at 20 to 30 fr. per 100 kilog., and give an average yield of 60 cubic metres of gas per kilog. the cost would be under 0·02 fr. (or less than the tenth part of a farthing) per gas jet, per hour. *Revue Indust. 9th June*, 1875.

Utilization of Spent Tan.—M. HONNIJ, of Chatelineau, Belgium, has discovered an apparently very useful means of turning a hitherto almost valueless article—spent tan—to good account. The process consists in the carbonization of the spent tan in an apparatus somewhat analogous to that used in the manufacture of coal gas. The following products are thus obtainable :—1. A gas suitable for lighting or heating purposes. When used for heating, the gas need not be purified by passing through the purifiers and refrigerators ; it is sufficiently cleansed for use by passing through a tank of water. If the gas be intended for lighting, all the smoke and vapour may be evaporated till the tan is thoroughly dry, thus avoiding any mixture of air with the gas. 2. Tar. 3. An essential oil in admixture with the tar ; suitable for lubricating machinery. 4. A carbon similar to charcoal, for which it may be substituted. 5. The carbonized tan may be used as fuel, alone, or mixed with other substances. 6. The carbonized tan may be reduced to powder, and used for making impalpable black, or in the manufacture of gunpowder. 7. When thoroughly dried the spent tan may be used in place of ligneous or fibrous substances, in the manufacture of paper pulp, pasteboard, buttons, &c. *Tanners' Journal, 1st July*, 1875.

Illuminating Gas from Human Excreta.—In our last number we transcribed some particulars of the failure of an attempt made at the gas-works at Breslau, to manufacture illuminating gas from excrementary matter by M. SINDERMANN'S process. A subsequent number of the journal quoted from, gives further details, from which it appears that the process was tried, on a small scale, by M. Sindermann, in presence of a committee appointed by the municipality of Breslau, and with complete success. By the distillation of excrementary matters, fluid as well as solid, in a small iron retort, heated over an ordinary coal fire, M. Sindermann succeeded in producing a gas that burned bright, and with a whiter flame than the ordinary coal-gas in use on the spot. Residuary products of some value were also obtained during the process ; a coke, rich in phosphates, and well suited for manure ; a tar bearing no traces either in appearance or smell of its origin ; a fatty substance, suitable for coating the interior of the vats, which would take the place of cesspools were the process followed up ; and a larger proportion of ammonia water than is obtained during the distillation of an equal volume of coal-gas. M. Sindermann estimates that 100 lbs. of fæcal matter treated by his process, would require 50 lbs. of coal, and yield 130 to 150 cubic feet of illuminating gas, or with an admixture of 1 per cent. iron filings, 400 cubic feet of gas, besides 6⅔ lbs. of coke, 3⅓ lbs. tar, and 3¼ lbs. fatty matter. No estimate was given of the proportion of ammonia-water. *Industrie-Blätter, 1st July*, 1875.

§ 6. *Miscellaneous.*

The Green Colour of Glass.—Glass containing soda has a light greenish tint, caused by the soda, and altogether distinct from the green shade resulting from the presence of iron. Like the latter, it may be eliminated by adding peroxide of manganese before or during fusion. The disappearance of the green is caused by the conversion of the protoxide into oxide of iron, the yellow tone of which is less apparent, or by the violet tint of the manganese, a complementary shade of green. Opinions are divided as to the condition of the manganese requisite to produce this effect. Liebig believed it to be the protoxide, Bontemps the peroxide.

To decide this question, Guhrauer, of Breslau, has instituted experiments, of which the following is a brief summary :—If the dose of manganese is too large, the glass takes a red colour. This is remedied by adding arsenic, sulphate of soda, or charcoal to the metal during fusion. The original green tint is thus restored, but the results are seldom quite satisfactory. Now, the arsenic and soda sulphate can only act as oxidisers, and the manganese must be in the state of protoxide or sesquioxide, which is converted into sesquioxide or peroxide, for it is scarcely admissible to suppose a higher degree of oxidation. Charcoal, on the other hand, can but act as a reducing agent, which renders the protoxide theory untenable, as any further reduction would set the manganese free in a metallic state, which would be noticeable in the glass. The loss of colour must therefore be due to the presence of manganese in the form of sesquioxide. If the proportion of peroxide is too small, or the furnace too slack, a green glass is obtained. In this case, too little $Mn_2 O_3$ is formed ; the manganese is in the form of protoxide or sesquioxide. By long exposure to the sun such glass becomes colourless. As this must arise from oxidation, the manganese must here be in the state of a protoxide. Very long exposure to the sun produces a violet tint, showing that the oxide is present in excess. It is possible that further oxidation would bring back the green tint again, by the conversion of the manganese into a colourless peroxide, for which it would be requisite that the oxide be brought back to the necessary proportion by partial oxidation. *Moniteur Indust. Belge, 1st July*, 1875. *Dingler's Polytech. Journal, t.* 213.

Waterproofing Paper. It is a well-known fact that *cellulose* is soluble in cuprous sulphate of ammonia ; paper, linen, and other vegetable tissues laid therein undergo a sort of surface-amalgamation of the fibres, which alters their absorbent powers. A sheet of paper so treated and dried afterwards, becomes impermeable to water, and this property is not effaced by subsequent boiling. Sheets of paper soaked in the sulphate and laid one upon the other and rolled, become amalgamated into a kind of cardboard, possessing great elasticity and cohesive power. The cuprous sulphate may be prepared by agitating copper filings in a closed vessel containing liquid ammonia of 0·88 sp. gr. *Isis (Haarlem), No.* 8, 1875.

Russian Industries.—According to a report lately presented to the Technical Society of St. Petersburg, the greater number of manufacturing establishments in Russia are under foreign management. In the St. Petersburg district, this is the case with twenty-eight out of thirty-two ; in the Moscow district, with twenty-two out of forty-seven ; in the Vistula, with six out of fourteen ; and in the Baltic provinces with twenty-one. The latest number of machine works is 167, of which three-fourths are engaged in the construction of locomotives and railway rolling-stock, and the rest in the manufacture of other description of machinery. Poland contains the largest number of industrial establishments ; the Baltic provinces come next, and then the centre and south of Russia. The above 167 establishments contain 422 steam-engines and 476 boilers, with an aggregate of 6,162 horse-power. The number of hands they employ is 41,380. They work up annually 133,800 tons of cast and 164,898 tons of wrought iron, and consume in the same time 127,000 tons of fuel, of which about 100,000 tons are coal and coke. *Revue Indust. 16th June*, 1875.

Heat-Conducting Powers of Soils.—Dr. A. VON LITTROW communicates the following as the results of late experiments on the heat-conducting powers of soils :—

In *dry* soils the capacity for conducting heat depends chiefly on the mechanical texture of the soil, especially on the character of the detritus washed out of it by the action of water, as is shown by microscopic investigation. In proportion as the tenuity of the constituent particles of a soil increases, its thermic conductibility decreases. It decreases notably also in soils containing organic matter. The effects of chemical and petrographic peculiarities appear to be as nothing compared with that of the mechanical constituents. The presence of lime and magnesia seems to diminish the conducting power.

Wet soils are better conductors of heat than dry, owing to the moisture contained in their pores. Wet soils, with one perfectly anomalous exception, are the best conductors of heat. Generally speaking, the substances of which soils are composed are in themselves better conductors of heat than is water. When the heat-conducting powers of soils are represented by curves, the curves of dry soils are found to occupy an intermediate place between those of air and water. The curves of wet soils rise above those of water, so that the thermic conductibility of water lies intermediate between those of dry and wet soils. *Les Mondes, from Journal de l'Académie des Sciences de Vienne*, 1875.

Manufacture of Chloride of Lime.—M. C. OPL, analyst to the Soda Manufactory at Fruschau, gives the following rules for the manufacture of chloride of lime of great strength, which will retain its power for a long time :—

1. The chlorine gas must be free from hydrochloric and carbonic acids, and should be brought to as low a temperature as possible in the chambers.

2. The hydrate of lime should be freed as much as possible from the carbonate, and should be used with sufficient water to allow of sieving.

3. During absorption, the chambers should be kept at a rather low temperature, never exceeding 25° C. (87° Fahr.) They should be so constructed as to admit of easy and frequent cleaning out.

4. As soon as the chloride of lime is removed from the chambers, it should be carefully triturated, and placed in flat wooden boxes, provided with lids, where it should be repeatedly turned over with a shovel, until its temperature is that of the surrounding air, or, at any rate, not in excess of 21° C. It may then be packed in casks.

If packed away as soon as it leaves the chambers, without having time to cool, chloride of lime is almost sure to decompose. During the summer heats, the decomposition is sometimes so sudden, that the chloride appears to lose its power instantaneously. It then assumes a pinkish tinge. *Technologiste, June*, 1875.

Reported New Source of Sulphur.—The "Pharmacist" for June quotes an account given by Professor GESSNER of a visit which he made in March last to the island of Saba, in the Dutch West Indies, for the purpose of examining the sulphur deposits there. Professor Gessner describes the island as a volcanic cone, about two miles in diameter and three thousand feet in height at the peak, Leverock, the principal town and seat of government, being situated in a bowl-shaped valley formed by the old crater, one thousand feet above the level of the sea. He speaks of one bed of brimstone as being forty feet thick, and extending a considerable distance, the mass of the bed being gypsum, containing on an average sixty per cent. of sulphur. He states that in many places masses of quite pure sulphur occur, several hundreds of pounds in weight, and resembling brimstone poured into irregular moulds. All volcanic action is reported to have ceased in Saba so long ago, that the sulphur beds are now quite cool and give forth no vapours to interrupt the working of them. Professor Gessner concludes his report by expressing his belief that this island contains one of the largest and certainly the most accessible deposits of brimstone in the world. *Pharmacist, June*, 1875.

The Odometer.—This name is given to an improved form of pedometer brought out by MM. GONZENBACH and HETZEL of Vienna. It is a small, watch-like instrument with a dial, and a couple of hands, the movements of which are regulated by a small pendulum inside, whose oscillations are caused by the wearer's movements. It is made in two sizes. In No. 1, which will be found useful for engineers and surveyors in checking chain-measurements and the like, and for military men in determining ranges at target practice, the dial of the long hand is divided into 10 spaces of 100 metres each ; these are subdivided into 10-metre spaces, so that a distance of one metre may be easily determined by estimation. The dial of the small hand, circumscribed within the other like the seconds dial of an ordinary watch, is divided into 10 spaces of 10 kilom. each. In No. 2, which is recommended for municipal measurements, and for the use of staff-officers, tourists, &c., the large dial is divided into 10 spaces of 50 m. and the smaller into the same number of spaces of one kilom. each.

In both the pendulum is set for a pace of one metre, but can be adjusted before use, by lengthening or shortening the bob, so as to suit any length of pace.

It is claimed for the odometer that it is cheaper, lighter, and far more accurate than any form of pedometer yet introduced. It is manufactured in Switzerland expressly for MM. Gonzenbach and Hetzel, 6, Jacobstrasse, Vienna, of whom alone it is procurable. *Zeitschrift des Ingr.- und Architekten-Vereins, No.* 10, 1875.

Hydrocarburets produced by the Distillation of Fatty Acids in Presence of Superheated Steam.—MM. CAHOURS and DEMARÇAY have examined samples of a volatile oil, produced at the Stearine Candle Factory, at Marseilles, by the distillation of fatty acids in a current of superheated steam, and find them to contain the hydrides of amyl, hexyle, heptyle, octyle, nonyle, decyle, undecyle, and duodecyle. A comparison with hydrocarburets extracted from samples of American petroleum, left no doubt that these compounds are identical in their origin. *Comptes Rendus, lxxx. 28th June*, 1875.

Tempered Glass.—M. A. BAUER, who has devoted great attention to this problem, and appears to have solved it by a method analogous to that of M. de la Bastie, has just made known the results of his labours. His glass does not differ in appearance from ordinary glass, but it emits a peculiar sound when struck ; it will bear being thrown on the ground repeatedly without breaking, and when it does fracture, it gives a great number of minute angular fragments. M. Bauer's process consists in heating ordinary glass until it becomes soft, then plunging it in a bath of melted paraffin at a temperature of 200° C. The sheets are not cooled slowly and gradually, but very suddenly at first, and very slowly after a certain temperature has been reached. After this treatment the glass will no longer take the diamond.

Not only is its consistency augmented, as shown by the superior hardness, but its specific gravity is also increased. Experiments showed that the latter in one case had increased from 2·424 to 2·438, and in another from 2·460 to 2·468. *Revue Indust. 30th June*, 1875.

New Sources of India-Rubber.—It is well known that india-rubber exists in the milky juices of many plants besides the caoutchouc-tree, as in the lettuce and dandelion. A company has been formed in London (Ontario), for the extraction of caoutchouc from "milkweed" (*Euphorbia corollata*), the juice of which contains about 4 per cent. of rubber. The plant is partially decomposed, steamed, and treated with coal-tar naphtha, which being distilled leaves the caoutchouc in the solid form. *Journal of Applied Science.*

Artificial Leather.—From the undermentioned source we learn that the manufacture of artificial leather, which attracted some notice in the Danish section of the late Vienna Exhibition, has made satisfactory progress in Denmark. There are now three manufactories in work, one in Copenhagen and two in the provinces, turning out 1,000 pairs of soles of this material daily, taking one day with another. The material is said to stand competition with natural leather in the home market, but the quantity manufactured has not hitherto been sufficient to lead to any attempt to export. *Industri-Tidende (Copenhagen), 6th June*, 1875.

Manufacture of Chlorine Gas.—FELS, of Hrastnigg, adds an excess of hydrochloric acid to a solution of potassium dichromate, saturated with sulphuric acid, thereby liberating chlorine gas at an ordinary temperature. By ebullition the formation of the gas is accelerated, and may be considered complete, when the liquor takes a green colour. In this way the whole of the chlorine in the hydrochloric acid is obtained, quietly and regularly, without effervescence, and with ordinary apparatus. The alum of chrome, which forms as a residue, covers the cost of the materials. *Revue Indust., 14th July*, 1875.

THE LEADING SHOWS OF THE YEAR.

BATH SOCIETY'S MEETING AT CROYDON (CONCLUDING NOTICE), AND ROYAL AGRICULTURAL SOCIETY'S MEETING AT TAUNTON (FIRST NOTICE).

THE great novelty of the Steam Cultivating Department, if not, indeed, *the* novelty of the Show Yard at Croydon, was the improvement exhibited for the first time, and under all the advantages of actual work in the field, in "Campain's Self-moving Anchor," the invention of MR. SAVAGE. The anchor was shown at work, and formed part of the steam cultivating mechanism manufactured by Messrs. Barford & Perkins, of Peterborough, who have used Campain's anchor since its introduction. The system worked by these engineers is that known as the "roundabout system" of wire-rope traction. For the benefit of those of our readers who are not acquainted with the modes of working implements by steam power, and also for the better understanding of one or two of the points of improvement in the new anchor above alluded to, we give in fig. 1 a rough sketch of the field laid out in the roundabout system, as worked by Messrs. Barford & Perkins (they have another system, in which the engine and windlass are combined). In fig. 1 let *a* repre-

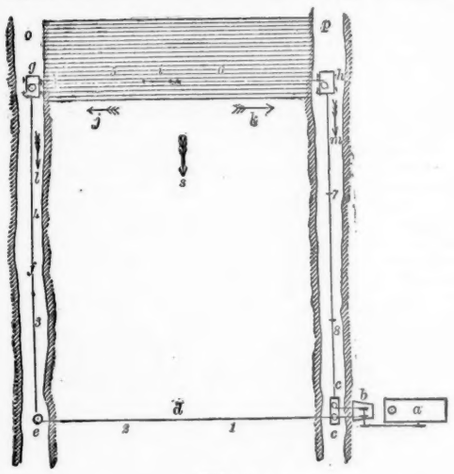


Fig. 1.

sent the portable steam engine which works the windlass, *b*, giving out and hauling in the wire rope. This, in the first instance, is passed round one of the pulleys of a "double snatch block" *c*, which in itself, we may remark in passing, is a very clever and simple arrangement, greatly facilitating the even coiling off and on of the rope round the barrels or drums of the windlass *b*, passed out in the direction *d*, round a pulley *e*, then in the direction *f*, round the pulley of the anchor *g*, then across the field in the direction between *g* and *h*, *h* being the second anchor, then from this to the second pulley of the snatch block *c*, and from thence to the windlass drum. The plough, or cultivator, is represented at *i*, and traverses to and fro between the anchors in the direction of the arrows *j* and *k*, and the anchors moving in the direction of the arrows *l* and *m*, along the "headlands" *o o*, *p p*, as the narrow strips of land bounding the field A, on each side are called. To keep the rope from running in contact with the soil, it is supported at intervals by pulleys raised some distance above the soil on standards, the whole being called "rope porters." These are placed as at the points 1, 2, 3, 4, 5, 6, 7, and 8; and of these only the two marked 5 and 6 are required to be moved frequently, those being at each traverse of the plough across the field, in order to get it out of the way of the advancing implement. The plough—if a plough be used, and not a cultivator—is on the "one-way" principle—see further on for a description of this—throwing all the furrows in one direction, or rather at the same angle. The drums of the windlass *b* alternately wind and unwind the wire-rope, according as the implement is traversing across the field A, in the direction of the arrow *j* or *k*; and as the field is gradually ploughed in the direction of the arrow *s*, the anchors are moved along the headlands *o o*, *p p*, in the direction of the arrows *l* and *m*, to an extent each time coincident with the distance of field ploughed in the direction of the arrow *s*. To make the necessary movement of the anchor as much self-acting as possible, dispensing with manual labour, many contrivances have been adopted from time to time; but of all those introduced, it is not invidious to the claims of others to say that that invented by Mr. Campain stood amongst the highest for simplicity of arrangement and efficiency in working. All complicated gearing was avoided by adopting the principle of making the dragging rope, or that which pulled the implement, the means of moving the anchor; simply by passing it round a pulley, the drag or strain of the rope pulling forward the anchor.

On examining the diagram in fig. 1, and considering what we have said as to the movement of the anchor being dependent upon the drag of the pulling rope of the plough *i*, it will be seen that the movement of the anchor will be a continuous one. Now this in practice is not required; the anchor being required to move forward, say on the headland *o o*, in the direction of the arrow *l*, at the time when the plough I has got up to the headland, and has finished what is called its "bout" or journey from the point *h* to *g*. To prevent this continuous forward motion of the anchor, it was provided at its back part, as at *g*, with a cross shaft carrying a set of curved claws or tines, which sinking into the soil held the anchor back, and prevented the forward strain of the dragging rope from acting. The cross-shaft carrying the holding-on claws was provided with a ratchet into which a pawl engaged, this pawl being connected with a lever. Now when the plough got up to the end of its journey this lever was lifted up, the pawl was disengaged from the ratchet, and the cross-shaft being allowed to rise, its claws got released from the soil, and there being nothing now to hold back the anchor, and as the dragging of the plough had ceased, the whole strain of the rope was thrown on to the pulley of the anchor, and it was moved along the headland the necessary distance; on this being attained, that is, till it had reached the point necessary to put the plough in its proper place for its return journey, say from *g* to *h*, fig. 1, the lever was put down, and the claws once more put in gripping position of the soil. Nothing could apparently be more simple and effective, but the anchor, nevertheless, had its defects. As for example: the strain on the pulley being a resultant, so to say, of the component forces of the rope pulling the plough in the direction of arrow *j*, and the rope pulling in the direction of arrow *l*; it was not in a direct line or at right angles to the line of furrow as *g h*; there was a tendency therefore in the anchor to take to the field *a*, or move towards the plough. Again if the soil of the headland was soft, the anchor could not resist the forward strain of the rope, and, in some instances, the strain was not sufficient to drag the anchor forward, and the plough still continuing to move, this was apt to be pulled up towards the anchor. All these defects have been got rid of by a very simple plan. To the axle of the pulley of the anchor a lever is fixed; this lies horizontally above the anchor pulley, and is carried forward a little beyond its periphery; the extremity of the lever being hollowed out spoon-fashion to receive a ball, which is fixed at any desired point to the rope dragging the plough. To the end of the lever at the axle of the anchor-pulley, another lever is connected, forming in fact part of the horizontal lever, and carried to the back of the frame of the anchor, where it is jointed to a lever connected with the pawl acting on the ratchet of the cross-shaft carrying the holding-on claws previously described. The action is as follows: on the ball—fixed to the rope pulling the plough—coming up to the pulley of the anchor, it enters the hollow of the spoon-shaped end of the horizontal lever, and as it cannot pass through the space through which the rope passes on its way round the periphery of the pulley; it presses the spoon-shaped end of the lever outwards from the pulley; correspondingly pulls backward the outer end of the back lever, and actuating the lever connected with the pawl; disengages this from the ratchet of the claw-shaft, releases these from their hold of the soil, and leaves the anchor at liberty to be pulled forward. This is done in a direct line, for the ball not permitting the rope to pass round the periphery of the pulley, the whole strain of the rope, as *g e*, fig. 1, is now transferred to the pulley of the anchor and in a straight line, and as the plough's forward motion is also stopped, it cannot be dragged on towards the anchor, nor has the anchor any tendency to leave the headland and take to the field A.

To those who are not in any way connected in business relationship with agriculture, even in the most remote and indirect manner, some "faint far-off echoes" of the sound, so to say, made by John Fowler—we would as soon think of writing about Mr. James Watt as Mr. John Fowler—must have reached their ears or their eyes, thanks to the daily papers—as to what he had done (and was doing) before death cut him off so suddenly—in the way of making steam cultivation an accomplished fact. By no means

ignoring the claims of others for practical work done in connection with this, and the theoretical expositions made known by a much wider host of others, we do no one an injustice in saying that to the indomitable energy, the untiring zeal, the enthusiasm which never flagged, under the most bitter and biting of disappointments, trials, and losses, displayed by John Fowler, and in a way as modest and retiring as it was effective, steam cultivation owes its present position. The story of his life and work is yet to be written; but when it is so, its chapters will help to fill the pages of the general history of the industrial triumphs which have tended to raise us as a nation to the proud position we now occupy. Time will show if the prophecies of those who "prophesy hard things" as to the future be true or not; certain it is that enough is being done by other people to make us look well to our laurels. These remarks in praise of one of our industrial heroes are by no means out of place—although parenthetical, so to say, to our special subject—in the pages of a journal, which has done more than any other in this country, to place on record what these heroes have been and done.

Steam cultivation has not only given the farmer a power by which he is enabled to undertake the working of a much greater breadth of land in a less space of time than before with the power of horses only at his command—and which is of course equivalent to a large saving in a double sense, as he can do more work and also take advantage of favourable hours of weather for doing it—but it has also enabled him to increase the depth of his cultivation, bringing ploughing nearer to what science indicates it should be than the mere surface-scratching of the soil which horse-ploughing gave him. But steam cultivation has done more than this; it has in what it has done in bringing sterile land

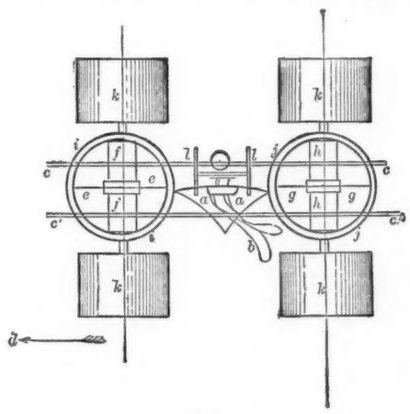


Fig. 2.

under culture given a still richer promise as to what it will yet do in this direction. Already in work in reclamation of waste lands it has done much, and in the doing of that it has given us the most satisfactory indications that it can do much more. Perhaps the most remarkable as it has been the most extensive work in this direction which steam power can do is that which has been done and is yet being done on the estates of the Duke of Sutherland at Lairg in the north. At the show yard of Croydon, at the stand of the Messrs. Fowler, there was exhibited one of the implements which has done no small share of the work of the reclamation above alluded to—work, we may say in passing, that is of a thoroughly national character, and deserves, as some day it will obtain, national recognition. This implement, designated as the "Sutherland Plough" or the "Marshland Plough," has been designed by the Messrs. Fowler to meet the peculiar character of the land it had to work, although one at least of its characteristics owes its excellence to the inventive talent of the Duke himself. This plough we now purpose to explain by the aid of a very small and rough diagram given in fig. 2, (drawings to scale we have in possession, and we may possibly present reduced copies of these to our readers at an early date). The principal feature of the implement is the plough, although it differs very materially from an ordinary plough in construction and arrangement of parts. It is provided with a flat plate *a a*, which carries the mould boards *b b*. The whole is hung from the frame *c′c″ c c* above, and in such a way that it can be reversed in position at the end of the journey, so that the implement does not require to be turned at the headlands; the rope which was previously the tail rope becomes now the dragging rope, that which was formerly the dragging being now the tail rope. Supposing the implement to be pulled by the wire rope (the mode of connection of which and its peculiarity we shall presently describe) in the direction of the arrow *d*, the soil is cut up or sliced off from the land side by the action of the disc or sharp-edge circular plate *e e*, passed on to the plough body *a a*, and mould boards *b b*, at which passes the slice on to the second disc *g g*, and roller *h h*, which presses the slice down with a pressure of at least a ton, and lays it in a good and sound position. The rollers *f f* and *h h* are carried by circular rings *i i*, *j j*, which revolve or are placed within horizontal rings fixed to the frame. The inner rings are placed on iron balls or friction rollers, and then provided with chains which are carried forward to the centre of the implement, and passed round a shaft worked by a worm wheel and screw and hand lever, this gearing or rather its position is indicated by the lines *l l*. According as the hand wheels are moved the chains are pulled right and left, and these pull the rings *i i*, *j j*, and the rollers *g g*, and *h h*, and of course change the position of the wheels or discs *e e*, *g g*, with relation to the framing *c c c c*, and thus help to steer the plough in difficult positions. The drum or broad-surfaced wheels *k k k k*, run on the unploughed land, those in the direction of the arrow *d* in the ploughed, and serve also to steer the implement and keep it steady. The sole of the plate *a a*, runs or slides along the bottom of the furrow; the level of the cutting edge of disc, *e e*, is a little above this, while that of the rollers is a little below the surface of the land. Another and an important use of the disc *e e* is, to rise or ride over any landfast stones, and to raise the implement and plough above these, while a hook or anchor-claw following the second disc *g g* catches these stones, raises them up, and throws them aside. There are two of these hooks or anchor claws; they are attached by an arm to a cross shaft, the position of which is somewhere about the points *c′ c″* on the frame *c c*, *c′ c″*. The arms are attached to these cross shafts close to the side *c′ c″* of the frame, and the

Fig. 3.

dragging wire rope is attached by a link to the back of the claw or hook, thus taking the traction at a very low point. At the end *c′*, when the arm is extended which carries the claw or hook, the back of the claw is towards or in the direction of the point of the arrow *d*, the point towards the feather; so that the anchor-claw or hook rides over or passes all stones; but the arm at the part *c′* of the frame is of course reversed, so that the claw catches the stones and drags them out.

As forming the basis of the plough used in steam cultivation, and as, moreover, being an implement to which attention, for several reasons, is now being devoted, we purpose here drawing the notice of our readers to the "one-way ploughs," a class of implement the peculiarities of which are not known to many, and indeed if we may judge from the utterances of some authorities, or who from their position ought at least to be such, are not known to some who should know all about them. The new name "one-way" is not so well known perhaps as the old name, for the implement is one which can claim a fairly high and honourable antiquity—the "Kentish turn-wrest," (there are those who have been puzzled as to the derivation of the name turn-WREST: is it derived from the action of the *wrist* in turning the hand when back uppermost to a position when the back is either to the right or left, the palm being then perpendicular? for this is precisely the movement made in changing the mould boards, and if this surmise be correct the name should be turn-wrist plough), although it distinguishes more clearly the character of the work which it does from that done by the ordinary plough. The plough had its origin in Kent; and for long, and indeed on many farms still in that fine old county, its construction and arrangement rendered it an implement as clumsy as could well be conceived in general appearance compared with

the neat and trim arrangements of the ordinary plough. Nevertheless the Kentish plough did first-rate work even on level lands, although it is designed to give its best work on hilly lands, for reasons which will presently appear. On looking attentively at a field ploughed by the ordinary plough, it will be observed that the furrow slices do not lie all in one direction or rather at the same angle; but if the eye steadily traces the plan of the field, so to say, it will come to a line —in fact a series of lines—on either side of which the furrow slices lie right and left. The central line, so to call it, is the central point of the "stetch" into a series of which the field is divided. An attentive observation of this peculiarity of position of the furrow slices of a field is we have said necessary; for out of a hundred, we might indeed with all safety say a thousand, spectators of a ploughed field, not more than one has noticed it. Now the reason why the furrow slices of a field ploughed by an

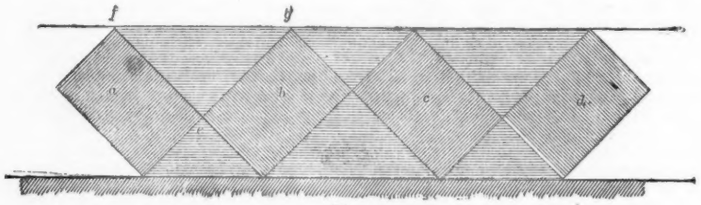


Fig. 4.

ordinary plough have this reversed or right and left position may be explained thus. Our readers know (or we presume them to know from our papers on "The Plough") that the form of the slice of an ordinary plough is rectangular, the proportion of breadth to length being somewhere about 7 to 10, and that this rectangular slice is laid over at an angle of 45°; the mould-board, which is a *fixed* member, and which thus turns over the furrow slice at this angle, is on the right hand of the plough. Suppose the plough to be ploughing in the direction of the line *a* to *b*, fig. 3; the furrow slice would be then over so as to lie at the angle *a*, fig. 4; now if the plough was turned sharp round at the end of its "bout," or journey, at the point *c*, so as to travel in the direction from *c* to *d*, the furrow slices would be turned over to the right as before, and would lie in the direction of the slice *b*, fig. 5, turning sharp round at the point *d*, and working down

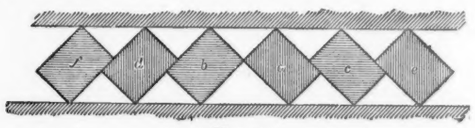


Fig. 5.

from *e* to *f*, the slices would be turned as before to the right, and lie as at *c*; *d* being the slice when the plough worked back again from *g* to *h*, and so on. It is obvious to those who know the object of ploughing that this arrangement of slices would not meet that object, for in addition to the formation of the maximum, sized open furrows *f*, *c*, *g*, the maximum area of the old surface in *f e* and *e g* would be exposed, and would not be covered up. To avoid these objections, the plan is adopted in practice, of working round the stetch from each side alternately, so that in the centre of the stetch the furrows lie in opposite directions, as *a* and *b*, fig. 5; all the other furrows being parallel to these on both sides till the outside of the stetch is reached.

The next stetch is worked in the same way with its two centre furrows, as at *a* and *b*, in fig. 5, the width of the stetch or the number of furrows in each varying in various districts, and was

Fig. 6.

determined by circumstances which came into operation "long, long ago." Generally speaking the prevailing influence was the distance between the wider furrows, which in these olden times were the only drains by which surface water was carried away, hence also the plan of working the stetches very convex or high in the centre, so that when harrowed down after seeding the water would "shed" as freely as possible to the furrows, as *a b*, fig. 6, at each side of the stetch. The mode of working round the stetch is illustrated in figs. 5 and 7. Thus, suppose the first bout is taken in the centre of the stetch or a little to the left of it, in the direction *a b*, the slice *a* is thrown over; the next bout, from *c* to *d*, turns over the furrowed slice *b*; travelling along the headland in the direction of the arrow *m*, the third bout is taken from *e* to *f*, throwing over the slice *c*; the plough is now taken along the headland in the direction of arrow *n*, and the fourth bout is taken, throwing over the slice *d*; going again along in the direction *m*, the fifth bout is taken from *i* to *j*, laying over the slice *e*, and the plough, traversing the headland in the direction *n*, takes the sixth bout from *k* to *l*, laying over the sixth slice *f*, which we may suppose finishes the stetch, which is thus gradually worked round, one half of its furrows laying to the right, the other half to the left. The "Kentish turn-wrest" plough turns the furrows all in one direction or way,

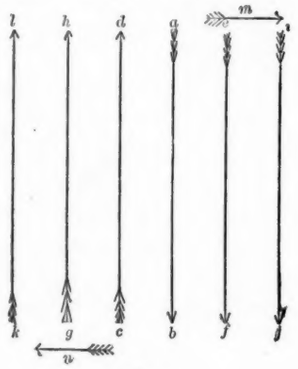


Fig. 7.

hence the other name, the "one-way plough," by which it is now more frequently designated. To effect this the mould-board is a *moveable* member, capable of being shifted from right to left and *vice versâ*, or, more correctly speaking, the mould-boards or parts representing these are two, the upper and the lower, the lower being the one which is at work, the upper the one which is free; by reversing these the plough is ready to work in the

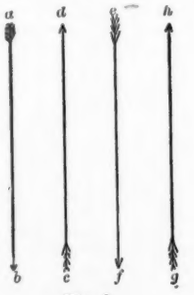


Fig. 8.

same direction. Its mode of working in the field is illustrated on figs. 8 and 9. Suppose the first bout is taken in the direction from *a* to *b*, and the first slice is laid, as at *a*, fig. 7, the plough is then turned sharp round, and, pointing in the direction *c* to *d*, the mould-board is shifted from the right to the left, and the second bout, from *c* to *d*, taken, and the second slice *b*, fig. 9, is laid over in the same direction as *a*. On arrival at

the point *b* the plough is turned sharp round, the mould-board changed from left to right, the third bout from *e* to *f* is taken and the third slice *c* laid over. The fourth slice is the work of the fourth bout *g* to *h*, the mould-board being again reversed at the point *g*. Thus all the slices lie in one direction. It must not be supposed, however, that the form of the mould-board of the original Kentish one-way plough is such as to turn over the slices at an angle of 45°, as in fig. 5. The mould-board is a very different member in construction from the finished mould-board of the ordinary plough with its mathematically-arranged outline. In the "Kentish" it is often little more than a board, its lower surface flat, its upper slightly rounded, as in fig. 10,

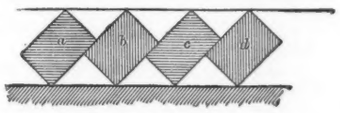


Fig. 9.

and it generally completely inverts the slice, leaving the surface which was bottom downwards upwards; and the grassy or upper surface downwards. The sock or share, called a "buck," is a flat spud-shaped or "duck-bill" tyne like that of a "broad-share" plough, as shown in fig. 11. This works in a line with that of the draught of the plough, and cuts, chiefly in a horizontal direction, the slice from the soil. As the mould-board is a moveable member so is the coulter, this being essential to meet the varying positions of the mould-board. The varying positions of the coulter in the "Kentish plough" is met in a very simple way, by having a slot cut in the beam, wider at the top than at the bottom, and thus permitting the coulter stem to be shifted

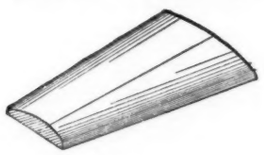


Fig. 10.

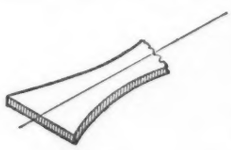


Fig. 11.

from side to side as desired. When adjusted, the coulter stern is kept in position by a stiff but flexible rod passing round the stud *a*, fig. 15, fixed on the beam *b b*, then round the coulter stern *c*, and finally round the stud *d*, the elasticity of the rod keeps the coulter stern firmly fixed in its place. Another method of changing and fixing the coulter coincident with the change in the mould-board, is shown in fig. 14, by having a lever fixed to the upper side of beam, by moving which from side to side the coulter stem is similarly moved; the lever being kept in place by a pin. The "Kentish plough" in its original form was and is a very clumsy, heavy implement, and great improvements have recently been introduced to make it

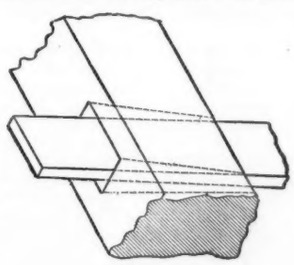


Fig. 12.

lighter and handier; of these, perhaps the best known and most highly esteemed is the form manufactured by Mr. Davey, of Crofthole, St. Germans, Cornwall, who exhibited one at Croydon, which took the first prize given by the Royal Society at Hull, and of which the following brief description will be interesting to our readers:—

The form of the plough bodies, of which there are two, in Mr. Davey's plough is the same as in the ordinary plough; each body having its finely curved mould-board. There is only one coulter, this being moved or changed in position as required, to meet the movement of the corresponding mould-board. There is also one sock or share only; this being adjustable also, as just stated, with reference to the coulter; and it is in the arrangement of these and the relative adjustment of one part to another, so that all the necessary movements are made to depend one upon another, and all made at the proper time, that the merit of Mr. Davey's one-way plough consists. A part or slot is cut out of the beam of the plough somewhat near its centre, so that it affords a space for a central axle or shaft, with bearings at each end. This shaft carries the plough-bodies with the mould-boards, so that the axle is common to both. The shaft is carried forward in the direction of the stilts or handles, and terminated between them at a point a few inches in advance of the central part of the beam. This end is provided with a slotted or open joint, carrying a pin; this pin is connected to a lever, which is carried forward and

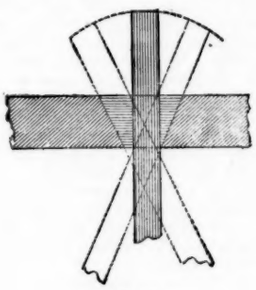


Fig. 13.

upwards, till it is terminated in a point within easy reach of the ploughman, the end of the lever being supported in the eye of a cross-bar between the handles, and furnished with a lever handle, resting, when not in use, on either one or other of the plough stilts or handles. By moving this lever from one side to the other, the shaft or axle carrying the plough-bodies can be moved from one side to another also, but in opposite directions, through the intervention of the lever connected by the pin previously named. This lever is carried downwards, and is jointed at its lower end to a shaft or axle, placed at an angle to the sole or flat part of the beam, on which the implement slides along the furrow bottom, this axle being carried

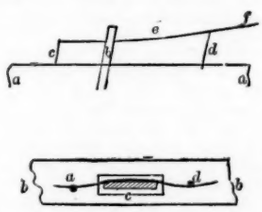


Fig. 14.

forward to the front of the beam or body of the plough, and connected thereat to the sock or share. On the plough reaching one end of the bout, it is turned sharp round ready to commence its return journey; at the same time the ploughman moves the lever between the handles, and causes the mould-board, which has been just working, to change its position, lifting it up out of contact with the soil, and leaving it suspended above the beam; while the other mould-board, previously suspended in a similar position, is lowered so as to come in contact with the soil, the sock or share being correspondingly moved from the one side to the other, by means of its axle (a lever neck as it is technically termed) moved by the lever jointed by its pin to the end of the shaft carrying the mould-boards. Two of the movements or changes required are thus so far effected—that of the mould-board, and that of the sock or share to suit it. The third movement, that of the coulter, is thus effected. Near the end of the beam a slot is cut through its entire depth, broader at the upper than at the lower side of the beam; into this slot the coulter shaft or shank is placed, and from the shape of the slot it is obviously capable of being moved, or made to sway, as it were, from side to side. It is kept in position by two pinching or set screws passing through the sides of the beam, one on each side. In front of the coulter slot, and attached to the beam, is a vertical stud or support, with rounded end. This is embraced by the eye of a lever, which is carried backward, and looped so as to embrace the upper end of the coulter shank; and thereafter carried backwards and sloped downwards, till it comes in contact with the face of one of the mould-boards, or it terminates at a point and in a line with the position which a mould-board will

present on being moved by the ploughman, by the handles and levers as already explained. The change, then, of the position of one of the mould-boards effects a change in the position of the coulter also, for as the mould-board moves, it strikes the end of the lever looped to the coulter shank, and causes this to turn on its stud, and moves the shank of the coulter in its slot from right to left, or *vice versâ*. The reader will thus see how, by a most ingenious yet simple arrangement, all the parts are made to adjust one another to its own particular and required position.

The "Royal" Show at Taunton.

Let outsiders say what they may as to agriculture—and strange things and not less untrue as to facts than strange to those who know what the real facts are—the "shows"—as the unhappily chosen phrase is—which are got up in connection with it, are really great events in the various districts in which they are held. And those of the leading societies—as for example, that of the Bath and West of England Society, the doings of which we have been for some weeks recording without exhausting all that could be said of them, and of the Royal Agricultural Society of England, the meeting of which has just come off at the "ancient and honourable" town of Taunton, are truly nothing more nor less than events of national importance. And that this is so, although strangely overlooked by the people generally, one has only to consider not merely the benefits which they confer upon an art which ministers so largely to the vital necessities of the population, alike of town and country, but the aggregate value of the "matériel," as the French say, of which these shows consist, and by which their attractiveness and utility are created and maintained. To the majority of our readers it will be no new thing to be told—but these pages may cross the eyes of some to whom it will not only be new, but "passing strange and suggestive"—that some firms in the agricultural implement trade spend as much as a thousand pounds—one thousand pounds, sir! as some would say, with a spicy smack of having a good thing passing between their lips—in getting up their "exhibits," and the expenses connected with the stands. Take the acreage of a Royal Society's Show Yard, cover it with its long extended ranges of sheds, fill these with their varied array of implements and machines, add to all these the long range of costly "machines in motion," and to these again the thousand and one appliances, useful in a variety of ways to farmers or farmers' wives; and keeping out of the reckoning the army—for in numbers it is nothing else—of live stock or the animals, some single specimen of which may bring, and has before now brought—a couple of thousand guineas, and the "tottle of the whole" mounts up to a sum, which, if named would surprise and justly surprise, those who have given no real analytical thought to the subject, but have heard of, spoken and thought about a Royal Agricultural Society's Show as a mere matter of course, and one of no great moment. But if to all we have named we add the enormous sums spent in the railway conveyance of the materials of these shows, the sums spent by those who visit them, and what they spend in "liquoring up"—and we suppose the sister phrase is "swallowing down"—we are thoroughly justified in calling such an event a national one in more aspects than one. And it is somewhat strange to say that no other calling has such expensive and splendidly organized shows. True we have our Exhibitions, local and otherwise, but those are general, in which agriculture takes a part along with other callings, so that none can claim precedence of another. Altogether, therefore, we have made good—and had space permitted, we could easily have made that better—our claim to have a Royal Society's Show to be considered a truly national undertaking.

The one opened—so far as the public was concerned, on the 12th of last month, but for the trials a week earlier—at Taunton, although in some respects smaller than others which have preceded it, was a good exemplification of the position above assumed. The showyard occupied a space no less than nearly sixty acres in surface; the number of stands being 284, and the articles exhibited in the show no fewer than 4,214. But this did not exhaust all of what may be called the popular evidences of the importance of such national gatherings; for to the acreage devoted to the showyard proper, must be added that of the grass fields devoted to the trials of the mowing machines, and horse rakes or haymaking machines—more than sixty acres—and still to these we have to add the fields appropriated to the working of steam cultivating apparatus. Although these latter were not provided by the society, but were hired at the expense of the makers, in place of not going to the "credit side" of the popular or national aspect of the show, they should in reality go very far; inasmuch as they indicate that such gatherings are and must be of great importance, and are fully appreciated, so far as their commercial influence extends, where private firms go to the expense, necessarily very great, of taking down machinery specially to work at the show, and to hire fields for the work to be done in.

Some of our readers may not be aware that the Royal Agricultural Society of England "try" each year only a certain class of machines and implements; it having been found that under the old system where all are subjected to trial, the proper amount of time and degree of care could not be given to such a wide range of mechanism, as to give to the results of their trials that degree of trustworthiness and certainty which their importance deserved. The class of machines selected for trial this year at Taunton were those connected with the "hay harvest," comprising (1) "mowing machines" for one and two horses, (2) "hay-making or tedding machines," (3) "hay-rakes," self-acting and hand worked.

The number of machines entered for competition for the prizes—£20 first, £10 second, and £5 third, for one-horse mowing—machines was 18, the number of competitors, some trying more than one machine, being 14; amongst whom were some of the best known of the trade, such as Samuelson and Co., of Banbury; Walter A. Wood, of London; Hornsby and Son, Grantham; and Picksley, Sims, and Co., of Leigh, near Manchester. The number of makers entered for the competition for "two-horse mowers"—prizes being £30, £20, and £10—was 18, amongst whom were the well-known men as named above; and others less widely known, but who from the excellence of the machines they are producing are rapidly coming to the front.

For "hay-making or tedding machines," the makers who entered for competition were the well-known firms of Messrs. W. N. Nicholson and Co., of Newark; Messrs. Ashby, Jeffery, and Luke, of Stamford; the Reading Iron Company; Mr. Boby, of Bury St. Edmunds; Messrs. Beare, of Newton Abbot; Messrs. Affleck of Swindon.

For "hay horse rakes, not self-acting," there were 11 machines entered for competition, and for the "self-acting," 24; the leading makers being Messrs. Nicholson and Co., Newark; Messrs. Picksley, Sims, and Co., of Leigh; Messrs. Bull, Kettering; Messrs. Page and Co., Bedford; the Reading Iron Works; the Bristol Waggon Works; Messrs. Haughton and Thompson, Carlisle.

In consequence of the number of accidents which have happened since the introduction of steam-worked corn thrashing machines, and the probability that sooner or later—it is to be hoped, the sooner rather than the later—the legislature will insist upon agricultural machines being guarded off as well as those used in manufactories; the Council of the Society offered this year two special prizes; first for "the best guard or appliance to the drum of a thrashing machine," and second for the "best combined guard and feeder to ditto." For the first, or class (*a*) there were 17, for the second, or class (*b*) 11 entries; the makers comprising such well known firms as Messrs. Clayton, Shuttleworth and Co., of Lincoln; Messrs. Robey and Co., of do.; Messrs. Hornsby and Son, Grantham; Messrs. Nalder and Nalder, Wantage; Messrs. Marshall, Sons, and Co., Gainsborough; Messrs. Rushton, Proctor, and Co., Lincoln; and J. P. Fison, Cambridge.

In consequence of the heavy work of the judges in connection with the mowing machines, the awards, at the time we write these lines, have not been made, but in connection with the other departments the following are the "awards" announced. (1) Hay Making Machines or Hay Tedders; first prize, Ashby, Jeffery, and Luke, Stamford; second, ditto; third, Reading Iron Works; commended, Nicholson and Co., and the Reading Iron Works. (2) Hay Horse Rakes, self-acting; first prize, Nicholson and Co.; second, Haughton and Thompson. (3) Horse Rakes, not self-acting, first and second prizes to Nicholson and Co.; Highly commended, do. For class A of the Thrashing Machine Grand Prizes: first prize J. P. Fison; second W. Tasker and Sons. For class B, first prize, Messrs. Clayton and Shuttleworth; second, Marshall and Sons. The awards for the "Mowing Machines" show that for the "one-horse mowing machines" Messrs. Hornsby and Sons took the only prize awarded, all the others having been disqualified in consequence of their draught exceeding the specified amount, namely, 30,000 pounds per foot per minute; the same firm took all the three classes of prizes for two-horse machines; Messrs. Samuelson being highly commended for two of these machines, and the following commended—Messrs. Harrison, Macgregor, and Co., Messrs. Burgess and Key, and Mr. Walter A. Wood. We should add, as indicative of the application of science to farming, that a prize was offered (special) for the most economical apparatus for drying hay in wet weather; it must not, however, be taken as indicative of the fact that science has not come forward in the way expected of her, that *no entry* was made for this prize. For

although this is the case, it is only right to add that hay-drying by artificial heat is an accomplished fact, a very ingenious apparatus having been for some years at work, the invention of Mr. W. A. Gibbs, of Gillwell Park, Sewardstone, Essex, of which we may shortly give a description. The judges in the Implement Department had at their disposal ten special prizes (silver medals); of these two only were awarded for inventions of special merit in the general showyard—one being given for the improvement in Campion's self-moving anchor, which we have described in our notice of the Croydon Show, and the other to Mr. L. Augustus Aspinwall, of 449, Strand, London, for his potatoe-planting machine. In succeeding papers we shall take up in detail the work and the novelties of this the great gathering of the year.

ABATTOIR MANAGEMENT AT CHICAGO.[1]

IN a paper read before the American Health Association at Philadelphia, in November last, Dr. B. C. Miller, Sanatory Superintendent at Chicago, gave some useful details relative to the management of the slaughter-houses in that city, especially with reference to the disposal of the refuse, solid as well as gaseous.

Observing that the care of animals devoted to slaughter, the best modes of slaughtering them, and the best methods of utilizing or disposing of the refuse thence arising are grave questions, affecting not only the comfort, but the health of every resident in great cities, Dr. Miller proceeded to state that at Chicago, previous to the year 1865, little attention was paid to such matters; the accommodation in the several stockyards in the city was very imperfect; the pens were not planked, and the cattle stood up to their knees in mud. That year the new yards of the Union Stockyard Company were opened, and the cattle have since been concentrated at that one point. All the Company's yards are drained as well as the nature of the ground will admit; the roadways and alleys are macadamized; the pens for the cattle are planked, and those for hogs and sheep are roofed as well, to protect the animals from the weather. Water is laid on throughout the yards from an Artesian well. A large number of hands are continually employed in keeping the pens clean; and every effort is made to render the animals as comfortable as possible.

Inspectors pass through the yards constantly, and all maimed and diseased cattle found there are not permitted to leave the yard, but are killed and sold to a company that owns a rendering establishment on the Calumet River, about twenty miles from the city, whither the carcases are taken, and boiled down for their fat. In this way maimed and diseased cattle are prevented from going into the market, and being sold as sound.

The following table gives the average number of animals received during each of the three first years after the opening of the Stock Company's yards:

Hogs	688,140
Sheep	179,880
Cattle	330,301

In 1873, the numbers were as below, showing an increase of over 4 million head:—

Hogs	291,734
Sheep	4,337,750
Cattle	761,428

Before 1865 nothing had been done in regard of the gases generated in the rendering tanks. In many slaughter-houses closed tanks were not in use, the cooking being done in open kettles; and when tanks were used, the gases and steam were permitted to escape into the air, and in certain states of the wind were carried over the whole city.

Every year brought an increase in the number of animals slaughtered, and an increase also in the number of packing-houses with their attendant evils. Nothing was done to utilize the "tank-refuse" or offal after removal, the only thought was how to get rid of it. Before the river was frozen boatloads were "dumped" in the lake, some miles from the shore; and when navigation closed, the refuse was buried on the prairies to give variety to the city smells when warmed up by the summer sun.

Some estimate may be formed of the enormous quantity of tank-refuse requiring to be disposed of, by calling to mind that an average cow gives 50 lbs. of offal, a hog, 20 lbs., a sheep, 7 lbs. The total amount of tank refuse or offal disposed of during the year 1873 was 22,784,360 lbs.

The first effort towards getting rid of the gases was a Board of Health regulation requiring the use of tanks from which the steam passed through pipes to a condenser, and thence, with a portion of the gases, into the street sewer. This was not altogether satisfactory in its working, although a decided improvement.

Steps were also taken to dispose of the solid refuse. Baugh's Drier was adopted by one company, and an attempt made to turn the refuse to use as a fertilizer, by drying. The drying was accomplished, but the effluvia were so offensive that the works were indicted as a nuisance.

Baugh's Drier is an inclined revolving cylinder 30 ft. long and 3 ft. in diameter, heated by fireplaces underneath and a current of hot air traversing the cylinder. The latter is fed at the upper end with the refuse, which takes about ten minutes to pass through, being carried out at the opposite end in a dry state. One to two tons of refuse can be dried in an hour. The gases generated during the process pass to a condenser, and thence into a chamber (a comparatively new addition), the temperature of which is 2,100°. There they meet with flame, and dripping hydro-carbon oils are burned, the residue going up the chimney. Dr. Miller's experience goes to show that the apparatus cannot be used without the addition of a gas chamber, on account of the enormous volumes of smoke and steam discharged through the chimney, and the dreadful stench emitted; but that with such addition, scarcely any smoke is perceptible, and the process can be carried on without giving serious offence.

Another apparatus used at several packing-houses is Edwards' machine. This also is a revolving cylinder, in which the refuse is dried for use as a fertilizer, and which is fitted with an air-chamber of peculiar construction. The heat is applied under the cylinder, none entering it except the small quantity that escapes through the openings of the air-chamber. About one and a-half tons can be dried at a charge, taking three hours. As originally constructed, the machine had no provision for the destruction of the gases, which were allowed to escape into the air. Lately, the owners of these machines have attached to it Bradley's process for destroying the gases, and also added escape-pipes from the rendering-tanks, the sewer-pipes having been discontinued.

Bradley's process consists of a pipe leading from the drier and tanks to an upright boiler 30 ft. high, filled with bricks so placed that water can percolate between them freely, and escape from the bottom into a pipe connected with the sewer. From the top of the boiler a large pipe leads to a second upright boiler filled with bricks in the same way. Extending from the top of the latter is a pipe leading to a rapidly rotating fan, which draws the gases and steam from the driers and tanks, and drives them into a chamber underneath the furnace bars, where they pass through the fire and are destroyed. In passing through the boilers the steam and vapoury portion of the gases are brought into contact with a stream of water percolating through the bricks, and are condensed, passing ultimately with the water into the sewer. The dry gases only are driven under the furnace. This machine has been too short a time in use for its merits to be fully ascertained. It is considered an undoubted improvement on the old method.

Another method is Storer's. This has been in use two years, and has given general satisfaction. The machine consists of an inclined bricklined cylinder revolving on friction rollers, with a fire placed at one end, and a chimney at the other. The heat is applied inside the cylinder by using pulverized fuel, the offal being rapidly dried by contact with the flame. The cylinder is fed at the furnace end by an elevator, and the refuse, after encountering the fuel, passes rapidly through the cylinder, and comes out at the base of the smoke stack. Passing through such intense heat, and drying so rapidly, enormous quantities of steam and gases are evolved. These are carried into a combustion chamber, in the form of an inverted cone, with perforations opening into the smoke stack. At the bottom of the cone is a grate with a coal fire. Above the fire, through an opening in the side of the cone, a jet of pulverized fuel is injected, igniting as it enters, and keeping the chamber at a white heat. By the passing of the gases through the chamber and grate, they are claimed to be destroyed. Experiments to test this point have proved very satisfactory; even a wet blanket laid over the mouth of the smoke stack retained no odour.

The latest machine is the Tobey Drier. This consists of two cylinders, an outer, 12 or 15 ft. long, made of boiler iron, after the fashion of a steam-jacket; and an inner, hollow, about 16 in. in diameter, and covered with teeth, which comminute the offal passing between the cylinders. The latter are heated by the

[1] This paper is published in full, with figures of the various machines referred to, in the "Journal of the Franklin Institute of Philadelphia" for May, 1875.

surplus steam of the boilers in the packing house. The material passes through in about ten minutes. On the top of the small cylinder is a dome, through which the gases pass upwards to a pipe leading to a condenser composed of a chamber and a copper pipe with a blind end full of minute perforations. The steam and gases entering the chamber come in contact with fine streams of water trickling from the perforations, and the steam part of the gases is condensed and carried off with the water into the sewer. One of the best features of this apparatus appears to be its economy of working. It can be worked with the surplus steam of a packing-house, and its capacity allows the offal to be disposed of as fast as the fat is removed, thus avoiding accumulations of refuse, and permitting no material to grow rancid.

With the exception of the Hogel machine, which is heated by steam, the above includes all the more prominent machines in use at Chicago. There can be no doubt that by the use of these machines the tank-refuse may be got rid of without causing any serious public inconvenience.

Reference has been incidentally made above to the gases that form in the tanks. After the Board of Health made the use of closed tanks and condensers compulsory, many experiments were instituted with a view to the destruction of the tank-gases. Amongst the most successful was the method patented by Mr. James Turner. In this, after the steam is condensed, the gases are carried off by a pipe to an iron tank, 50 ft. from the building, where they pass through gasaline or other hydrocarbon oils, and are brought back under the boiler and burned. The amount of gases generated in a large packing-house is sufficient after being carbonized to generate heat enough to effect a considerable saving of fuel.

The patentee is now placing a gasometer in connection with his carbonizers, in which the same gas will be stored in quantity sufficient to light the packing-house.

Apart from the improvements in the methods of disposing of the offal and gaseous products, much, Dr. Miller states, has been done in other directions to reduce the number and mitigate the intensity of the nuisances connected with packing-houses.

The sewerage is now well looked after; every effort is made to obtain perfect ventilation, by external windows and the latest mechanical appliances of all sorts; stone floors have been substituted for wood in many of the cellars.

Packers, he adds, have learned that the more perfect the arrangements of their establishments, the more fully sanitary requirements can be met, and that in this way more work can be done and a better class of meat cured.

Practical Literature.

A MANUAL OF METALLURGY.[1]

A GOOD introduction to the study of metallurgical science, which shall be something more than a mere catalogue of the various metals, with a brief résumé of their properties and characteristics, and which shall yet not be too large or too elaborate for the student when first approaching the subject, has long been needed. The voluminous and exhaustive treatises of Dr. Percy, and others, indispensable as they are to all who wish to master the science, are hardly suited for such a purpose; and we are glad to be able to recommend these volumes as supplying the desideratum, and going so much farther into the subject as is necessary in order to qualify the student for the advanced stage of the Science and Art Department examinations.

The author's aim in these two volumes has been to present as accurate, useful, and comprehensive an account as possible of the typical and more generally employed methods pursued in the extraction of the useful metals from their ores; and to offer such explanations as are generally received of the scientific principles upon which they are based and metallurgical phenomena depend. The technical details of the various processes and their numerous modifications are not entered upon, nor are the subjects of assaying and the mechanical every-day appliances in use in metallurgical establishments, such as engines, fans, rolling mills, &c., the latter belonging more properly to the sphere of applied mechanics.

It will thus be seen that this is the work for which the need we have spoken of has existed, and to those who are practically engaged or interested in the conduct of the various processes of metallurgy it will prove a useful auxiliary to and résumé of the contents of the larger treatises on various divisions of the subject, while it will certainly take its place as a student's manual.

The works opens with chapters on metallurgical terms and fuel, and each metal is afterwards treated of in a separate chapter, its physical and chemical qualities being first discussed: it is then considered in its commercial aspect, and its application to arts and manufactures, and finally the various processes employed in its preparation are dealt with, together with any other points of practical interest which it may present.

We are glad to note that the modern chemical notation, nomenclature, and atomic weights are employed; and the author appears, so far as he has carried his subject, to have availed himself of the latest practical results which the investigations of science have achieved. Illustrations are employed where they are found needful to the elucidation of the text. A carefully compiled index and a complete table of contents are given; and we think the work altogether is one which will worthily fill the place it is intended to occupy.

[1] *A Manual of Metallurgy.* By W. H. Greenwood, F.C.S., Assoc. Royal School of Mines, &c. Volumes I. and II. London and Glasgow: Wm. Collins, Sons, and Co. 1875.

THE ACTS FOR THE BETTER MANAGEMENT OF THE HIGHWAYS IN ENGLAND.[1]

THIS is the fourth edition carefully revised by the son of the original compiler, Mr. W. C. Glen, of a very important and useful publication, which has already met with considerable favour among all for whose use it has been written. The present issue contains all the important decisions of the courts subsequent to the publication of the last editions, which bear directly upon the Highway Acts of 1862 and 1864, and, in addition to the contents as indicated by the title, the work comprises the incorporated clauses of the Commissoner's Clauses Act, 1847 and of the Common Law Procedure Act, 1854.

This is a work which should be in the hands of every country solicitor, and as an exposition of the powers and duties of those who have the management of highways, it will, we have no doubt, prove as useful as the editions which have preceded it.

THE AMATEUR'S GREENHOUSE AND CONSERVATORY.[2]

THE title-page of this book further describes it as "a handy guide to the construction and management of plant-houses, and the selection, cultivation, and improvement of ornamental greenhouse and conservatory plants;" and the work is certainly one which fully carries out the promise of its title. Thoroughly practical, clear in arrangement, and complete in the information it gives, it has already achieved a high position among books of its class, and many useful hints will be found in it which are not to be despised by the professional gardener, while for the amateur it is an invaluable manual.

It deals not only with the contents of the greenhouse and conservatory, but in the earlier portion it gives full details respecting the construction and various methods of heating the houses, having always in view the least expensive method of producing the best results. The habits and methods of treating almost every kind of greenhouse plant receive full attention, and the book is embellished with numerous wood engravings and several excellent coloured plates.

[1] *The Acts for the better Management of the Highways in England, 1862-1864, and the provisions of the Turnpike Acts relating to Highways, and the winding-up of Turnpike Trusts; with Introduction, Notes, and Index.* By Alex. Glen, M.A., LL.B., Cantab., Barrister-at-Law. London: Knight and Co. 1875.

[2] *The Amateur's Greenhouse and Conservatory.* By Shirley Hibberd, Author of "Rustic Adornments for Homes of Taste," &c. London: Groombridge and Sons. 1874.